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## THE GERMAN NATIONAL MONUMENT.

On September 28, 1883, the national monument on the Niederwald, overlooking the Rhine, was unveiled by the Emperor of Germany. The idea of such a monument was, says a correspondent of the London *Times*, mooted to Prince Bismarck by Count Eulenburg so early as the day of the signature of the Peace of Frankfort. Warmly approved by the Chancellor, the project soon after passed into the hands of an executive committee, which converted it into a resolution that received support throughout the nation. In the spring of 1873 the artists of all Germany were invited to send in models of a monument that would best express the idea and object of its erection; but though three of the twenty-six competitors were awarded prizes of honor, the jury declined to adopt any of their sketches. A second competition had no better result; but at last, in April, 1874, the jury expressed themselves thoroughly satisfied with the

HEAD OF THE STATUE OF GERMANIA—THE GERMAN NATIONAL MONUMENT.

architectural and sculptural plan of Professor Johannes Schilling, of Dresden, who was thereupon authorized by the grand committee, under the presidency of Herr Von Bennigsen, chief of the National Liberals, to proceed with its execution.

The cost of the monument, which is not expected to exceed the estimated sum of 1,100,000 marks, or 55,000*l.*, has been covered partly by public subscription and partly by Parliamentary aid. As much as 240,000 marks had been collected by 1874, but there was a falling off in the contributions in the reactionary era ensuing on the Gründerzeit, or time of rash and not over-honest commercial speculation prompted by the receipt of the French milliards; and though by 1878 the above sum had increased to 635,000 marks by the accumulation of interest, the sale of photographs, and collection lists of schools and veteran societies (Krieger-Vereine), the Reichstag in the following year saw itself compelled to vote a subsidy of 400,000 marks in order to insure the completion of the enterprise. In 1876 the necessary ground was purchased; in September of the following year the foundation stone was laid, and now the finished monument stands flashing high and far "on free hilltop by German stream" in all its proud and noble beauty.

The tourist as he passes up or down the river cannot but be struck with the shining monument away up on the Niederwald brow, but it is only when he has toiled up to it that he can take in all its expressive character and truly beautiful proportions. A colossal statue of Germania, said to be an idealized copy of the artist's own daughter, clad in a flowing girdle-bound robe, her left hand resting on the hilt of a drawn but laurel-sheathed sword, and her right holding high a laurel-wreathed imperial crown—that is what surmounts the huge statuary edifice and first fetters the eye. Beneath her mantle, which is richly embossed with historic symbolism, can be seen a coat of chain mail, over that being a steel breast-plate blazoned with the spread-eagle, and she is standing before an imperial or curule throne or chair. Underneath, on the pedestal, is the inscription, "In memory of the unanimous and victorious rising of the German people and of the restoration of the German Empire, 1870–71." On the one side of the pedestal are the names, "Weissenburg, Wörth, Spicheren, Courcelles, Marsla-Tour, Gravelotte, Beaumont, Sedan;" and on the other, "Strassburg, Metz, Le Bourget, Amiens, Orleans, Le Mans, St. Quentin, Paris." A succession of well laid out terraces and flights of steps lead up to the foot of the monument, the front basement of which presents two very large and finely sculptured recumbent figures—the Rhine and the Moselle—the former in the shape of a Father-Neptune-looking old man offering a cornucopia to his companion, a lovely nymph with an oar or rudder in her hand. Above that on the first socket is a magnificent relief group representing "Die Wacht am Rhein," flanked at the corners by two outstanding figures, War and Peace, each about six meters high—the former, an allegorical character, partly Mercury, partly mediæval knight, with blastful trump in one hand and sword in the other; the latter, a mild and modest angel maiden, holding out an olive branch in one hand and the full horn of peaceful blessings in the other. Between the two is the front facade, representing the "Watch on the Rhine"—a faithfully and splendidly executed relief group. In the center is the Emperor William on horseback against a background of the banners of the chief German cities, flanked on either side by the chief princes and generals, corps and divisional commanders, and statesmen—nearly two hundred in number—who helped by word or deed or counsel to found the Empire. The Kings of Saxony and Bavaria, the Crown Prince, Prince Frederick Charles, Bismarck, Moltke, Roon, and all the rest of the kaisers, princes, knights, and paladins are there—true to the life in breathing bronze; a rich storehouse and infallible standard in every respect; an Elgin marble slab, so to speak, of the German nation. In the corner of the facade relief next the figure of War is a group of combatant German soldiers, while on the other side, near Peace, warriors are shown in their career of victory. Beneath the group are inscribed five verses of the "Wacht am Rhein"—happy and thrice-to-be-envied poet to have his verse thus immortalized in bronze!—with the refrain in larger letters in one line under the whole:

> Lieb' Vaterland, magst ruhig sein,
> Fest steht und treu die Wacht am Rhein.
> (Dear Fatherland, thou needst not fear,
> Stands firm and true thy Rhine-watch here.)

On one side of the socket which bears the above described front facade another magnificent relief group represents the departure of the soldiers for the war, and their affecting leave-taking of parents, wives, and children; while on the other side is a similar portrayal of the return home of the laurel-crowned warriors. Above the Emperor, and in front of a second socket, sits perched a huge eagle—nearly 2½ meters high—with outstretched wings and the imperial shield on breast, while round the socket are hung the arms of all the chief States of Germany, above them being the iron cross, with various sorts of wreaths and garlands; and surmounting all, the colossal far-flashing statue of Germania—powerful, victorious, and proud. From the socket to the crown the monument measures about 25 meters. The Germania itself has a height of nearly 12 meters, and weighs 700 cwt. Its little finger can be spanned by two adults only; its thumb nail is 9 centimeters broad and 11 long. A man can creep through the hollow of the wrist, and inside the lower part of the body ten couples can conveniently dance. The sword is 8 meters long, and weighs from 5 cwt. to 6 cwt. That the monument should have been devised and completed in all its parts within eight years is justly regarded as a brilliant proof of German industry and perseverance. The technical and architectural difficulties to be overcome were immense. For the building of the lower part of the edifice stones of immense weight—some of them all the way from the Leutoburger Wald, weighing 900 kilogrammes—had to be dragged up the Niederwald slope by teams of a dozen and eighteen horses. For the modeling of the various parts of his masterpiece, Professor Schilling, of Dresden, had to erect huge scaffoldings; and when finished they were distributed among various German foundries to be cast. The moulding of the Germania fell to the lot of Herr Von Miller, of Munich, and when triumphantly turned out, like Schiller's "Bell," the question was how to transport it to its destination—by road or rail? The latter method being eventually chosen, the various portions of the statue were conveyed with laborious precaution as far as Rosengarten, opposite Worms, where legend fables the Nibelungen Hoard to lie embedded in the Rhine's pellucid depths, and there "the epic in bronze and stone" was confided to the river. Ringing cheers and salvos of cannon greeted the huge barge and its precious burden all down the Rhine to Rüdesheim, where it safely arrived and was gradually hauled and pushed up the Niederwald slope by strenuous and sweating teams of men and horses. But would the scaffolding bear the weight of the colossal metal fragments that had to be hoisted aloft? This was first successfully tested by the swinging up of 11,000 killogrammes of iron rails, then the main portion of the Germania, weighing 8,500 kilogrammes, was carefully elevated; and within a month of their removal from Munich, all the pieces had been triumphantly raised on high and fitted together. Though attended with great difficulty and danger, the laborious enterprise was accomplished without any loss of human life, the only serious mishap that marked its progress being the overthrowing of a heavy scaffold crane by a thunderstorm.

Such is a brief sketch of the work, but brief as it is it will speak volumes for the workman, who will henceforth take rank with the world's greatest masters of plastic art. Professor Johannes Schilling, of Dresden, the Florence of the North, is a Saxon by birth, and was born in 1828. After studying with Rietschel he made his *debut* as a sculptor in 1851, with a beautiful group—Amor and Psyche. Working then at Berlin with Drake—the artist of the Victory Column—he produced a pair of relief medallions, Jupiter and Venus, which procured him a traveling scholarship; and the result of the two years' residence in Italy which he was thus enabled to spend, were his Wounded Achilles and his Centaur and Venus. Returning to steady industry at Dresden, he turned out in rapid succession a variety of high productions; and on the death of Rietschel undertook the execution of the city of Spiers figure for the Luther monument at Worms. Tourists will remember with equal admiration his Four Seasons on the Brühl Terrace at Dresden, his Schiller statue at Vienna, his Maximilian statue at Trieste, and his War Memorial at Hamburg, not to mention other creations, which have now all been surpassed and crowned by his Niederwald monument—a work which will immortalize its author as it will perpetuate the memory of the events whereof it is the record in eloquent marble and breathing bronze.

The foregoing particulars are from the London *Architect*. For our engravings we are indebted to the *Illustrirte Zeitung*. In our SUPPLEMENT, No. 406, we gave engravings of interesting details of the construction and erection of this great monumental work.

## ANCIENT AND MODERN GLASS OF MURANO.

By JAMES JACKSON JARVES.

OF all the peoples which have made glass a special industry, the Venetians, for artistic variety and quality, are the most renowned. The Egyptians, Phœnicians, Greeks, and Romans in certain kinds are unrivaled, especially in moulded, cut, mosaic, and cameo glass, of which last the Portland and Neapolitan vases are unsurpassable specimens. With the Byzantines the art survived, but in a degenerate form, as with classical painting and sculpture. Nevertheless, there is little doubt that it was more or less extensively practiced at Constantinople and in Italy during the Dark Ages, although so little information and so few specimens of these times have reached us. In the form of mosaic it must have been extensively cultivated, at least from the fourth and fifth to the ninth and tenth centuries. We may be tolerably certain that the beginnings of the Venetian art came from Oriental and Byzantine sources. But there are no records relating to its glass previous to the twelfth century. In 1268 we have notices of scent bottles and table ware, and in 1275 the exportation of the materials used in the manufacture was prohibited. So rapidly did it grow into commercial importance that the State intervened to protect and encourage it in every possible way, and to make it a national monopoly. In this it succeeded so far that the fine manufacturers of Venice controlled the markets of the known world for centuries; and although more or less successful attempts were made in other countries to become independent of her, none ever succeeded in equaling the variety, beauty, and refinement of the best Venetian work. The republic wisely ennobled the art, and in 1376 decreed that the descendants of glass-blowers who intermarried into the noble families should be considered as patricians. Particular civil privileges were conferred on the guild. It was not amenable to the inferior courts, but was under the special jurisdiction of the celebrated Council of Ten.

Although Venice itself gives its name to the glass as early as 1291, the works in general were removed by statute order from that city, and established in the neighboring island of Murano, a mile to the northeast, where they were already in existence manufactories, but on a smaller scale. This was to guard against the risk of fires in the thickly populated city, and for sanitary reasons. Henceforth Murano became the chief locality of this industry, which finally took such proportions that the street along the chief canal, more than a mile long, became mainly devoted to it. Coccio Sabellico, in his account of Venice, written about 1495, thus alludes to Murano:

"There is a street which might, from the magnificence and size of its edifices to those who beheld it from afar, appear a city; it extends a mile in length, and is illustrious on account of its glass-houses. A famous invention first proved that glass might feign the whiteness of crystal, and as the wits of men are active and not slothful in adding something to inventions, they soon began to turn the material into various colors and numberless forms. Hence came cups, beakers, tankards, caldrons, ewers, candlesticks, animals of every sort, horns, necklaces; hence all things that can delight mankind; hence whatever can attract the eyes of mortals; and, what we could hardly dare to hope for, there is no kind of precious stone which cannot be imitated by the industry of the glass-workers. Consider to whom it did occur to include in a little ball all the sorts of flowers which clothe the meadows in spring.* Nor has the invention been confined to one house or family; the street glows for the most part with furnaces of this kind."

This is a graphic description of the condition of the industry at Murano in the latter part of the fifteenth century, when it was bordering on its most artistic and flourishing period, in which it was a virtual monopoly of the Republic. Murano so eclipsed all other Italian cities that none other ever acquired any reputation for glass. There were sufficient reasons for this success. Its secret processes were kept jealously guarded, and the skill of the workmen in various departments kept, as it were, in certain families, and transmitted from generation to generation.

Among the most distinguished were the Berovieri, the Miotti, Briati, and Ballerini, some of whose descendants are still engaged in the same occupation in the new establishments of Salviati and the Venezia-Murano companies, reproducing and even rivaling the artistic dexterity of their ancestors. Their chief aim was to make *artistic* glass exclusively for beauty; and, secondly, to ornament and shape even the articles of common use so that they should, as Sabellico happily expresses it, "attract the eyes of mortals" and "delight mankind." This vital æsthetic principle of work was the real secret of the fame and success of Venetian glass, as of its painting. In making beauty, not utility, its governing rule, it demonstrated by its commercial success and enrichment of the State that the higher the aim of industrial art, the surer the road to fortune as well as mental delight. It "paid" Venice amazingly well to give beauty its rightful place in manufactures, and be satisfied with nothing short of its fullest development. Besides seeking the best materials, and aiming at strength, delicacy, and lightness, which were promoted by not using lead, as is the general modern practice in glass, each manufactory so well kept its secrets that we now know very little of their modes of manufacture. The State lent its aid also in a series of Draconian enactments, which, if they did not wholly preclude competition in other places, mainly prevented it. Workmen who took their craft to foreign countries and refused to return were condemned to death, and secret emissaries were sent to execute the sentence. In 1549 it was enacted that workmen caught leaving the country should be fined and sent to the galleys, and that no foreigners be employed in the glass-houses. If it were a cherished and lucrative business at home, under the eyes of the "Ten," it was equally made a most dangerous calling to be exercised by any Venetian abroad.

As early as 1500, there were twenty-four glass-houses at work at Murano, each having more or less its specialty. The furnaces in general were small. During the period of its greatest prosperity—the fifteenth, sixteenth, and seventeenth centuries—Murano counted thirty thousand inhabitants—now reduced to about five thousand. Each owner of a factory was obliged to contribute annually a certain sum to a common fund for the succor of the unfortunate of their own class—poor and infirm artisans, or those out of employment, and for the maintenance of the schools of inventive design. No apprentice could be admitted as a masterworkman before passing a strict examination in his art, and proving his skill in the manufacture of certain objects. The candidate was elected into the body of masters by their secret ballots. Each factory was subject to inspection night or day by certain officers, whose duty it was to see that the work was regular according to the statutes, to note the quantity and quality of the objects, and that no glass in fragments, or cullet, be exported. Proprietors and masterworkmen of ten years' experience, if they honorably failed, and had no other means of subsistence, were entitled to pensions of seventy ducats annually. When there were more masterworkmen than could be profitably employed, it was forbidden to increase their number from the apprentices until there was a real call for new hands. Whoever became a member of the guild was obliged to take an oath of fidelity. No one who had not a regular discharge from his employer could be received into the service of another, and every proprietor was obliged to seal his cases with his own trade-mark. It was forbidden to employ strangers under any pretence. If there were not enough of the Muranese at times for labor, or to exercise the art, Venetians only might have the privilege, but they must be duly qualified. No employer could hire a master-workman who was in debt to another of the guild. Such were some of the regulations to keep the art in a high state of efficiency, and which for more than five centuries gave it an incontestable superiority in its special aim over all other establishments in Europe. In fine, Murano became as artistically famous for its glass as Urbino, Pesaro, Gubbio, or Chaffagiolo at the same time for their majolica, but with far greater commercial development.

Mr. Franks, somewhat incompletely but conveniently, so far as he goes, classifies the decorative glass as follows, in six divisions:

First. The transparent and colorless glass, or of single colors, commonly black, purple, blue, ruby, green, opalescent, amber, etc. Sometimes there are two colors in the body of the same vessel—one inside and the other on the outside. Frequently in the handles and external ornamentation a variety of colors twisted in light fantastic forms of extreme delicacy, or laid on in threads, is used, especially in drinking-vessels.

Second. The heavier Gothic or classical forms, originating in the fifteenth century, before the fashion changed to the extremely light and capricious shapes of the sixteenth, were profusely gilt and enameled. As these processes required considerable strength of material, they were confined to the heavier objects, in the form of bowls, cups, tumblers, salt-cellars, nuptial and other gift goblets. The decorations consisted chiefly of pictorial scenes, such as processions, portraits, coats of arms, inscriptions, allegories, scroll and lace work, and various intricate designs; sometimes merely flowers, garlands, or flower-like ornamentation in gold, diversified with many dots in lines representing pearls and precious stones, or scale decorations. In latter times, cups and dishes, instead of the more expensive and difficult enameling, were painted on their under surfaces in oil colors. As this form of glass requires not only great skill in its material preparation, but equal artistic talent, and is liable to many accidents in the furnace, it was always expensive and not common. Good specimens of the ancient are very rare, and the finest valued at thousands of dollars each, especially those done by Berovier, of whose work the nuptial cup at the Correr Museum at Venice is a noteworthy example, of about A. D. 1450.

Third. In the sixteenth century, glass with a rough surface, as if frosted or frozen, called *crackled*, first came in vogue; also the kind incrusted with fragments of glass of different colors, giving great brilliancy of effect to the roughened surfaces.

Fourth. The kind now common, but expensive, known as aventurine glass, was first made in the seventeenth century. But before this the fashion of imitating stones had begun, as also the opaque, variegated, marbled glass, commonly known as *schmelz*. The old specimens of jasper, lapis lazuli, tortoise-shell, agate, onyx, chalcedony, and mixed colors, chiefly in shape of essence and tear bottles, vases, jars, jugs, urns, etc., are extremely well done, colors intense and harmonious; but the modern are fast rivaling them, although, as we shall see, as yet not equal to Miotti's brilliant chalcedony, with its transmitted ruby light inside, or the earlier, softer, and more diversified aventurine. The modern is of a uniform, tiresome, mechanical, even sparkle, with no relief of tint and shade.

Fifth. In the fifteenth century, or perhaps earlier, began the attempts to revive the varieties of the old Roman and Etruscan mosaic glass, or what is known as the *millefiori*, or thousand flowers, which is made by the combinations of *canne*, or rods, in fusion and union of colors in divers patterns. The old Venetians were successful, but not to the ex-

* Referring to one kind of *Millefiori*—thousand flowers—glass made from *canne* or rods of different colors.

tent of quite equaling the taste and beauty displayed by the Romans in this line of art.

Sixth. The Venetians, however, surpassed the ancients in lace or reticulated and filigree glass—*vetro di trina, reticelle, filigrana*, and the milk-white (*latticinio*) varieties, in the manipulation of which they acquired great skill.

These divisions by no means include every species of work done by the old Venetians in this material. As early as the fifteenth century we have specimens of elaborate architectural compositions, like temples or tabernacles, and of cabinets, coffers, altars, crucifixes, and other objects of the most diversified, quaint, ornate, and complicated character, constructed of glass. Not only these, but statuettes and groups of figures in enameled glass, beautifully modeled, were fashioned; mirrors, frames, lamps, candelabra, beads and chandeliers of costly elegance and variety of ornamentation also were largely produced, not to mention the grotesque and picturesque shapes given to articles of common use. In the seventeenth century, engraving with the diamond point began to be practiced, generally in delicate lace pattern. The famous Giuseppe Briati in the next century successfully imitated the German and Bohemian cut and engraved glass to a certain extent, and was renowned for his glass-framed mirrors and chandeliers, ornamented in intaglio, and with foliage, fruits, and flowers. He revived also the best forms of the sixteenth century, especially the filigree and lace glass, with equal lightness and brilliancy, while his glass was of superior purity and clearness. His works were so much admired as to be put on a par at entertainments with the gold and silver plate. He died in 1772. With him passed away the best period of glass-making. Subsequently its forms became heavy and rococo. The fall of the Republic gave the death-blow to the industry, which virtually became a lost art until 1838, when Signori Rupolin, Bigaglia, Toso, Radis, and others sought to re-establish it, with, however, but indifferent success.

It was not until 1864 that any serious attempt with sufficient capital was made to revive the artistic manufacture of glass at Murano on its ancient scale. Assisted by several English gentlemen, Dr. Salviati formed his first company for this purpose, which after becoming successfully established, divided into two—that which now goes by his name, and the Venezia-Murano Company, under the auspices of Sir Henry Layard and Sir William Drake, Signor Castellani being the able director.

These companies had in reality to begin anew and feel their way backward to the old artistic forms and skill. The first effort was toward a revival of the ancient feeling for graceful, elegant, and varied form, without which the superior technical processes and chemistry of the nineteenth century would have been unavailing. Both companies have made extraordinary progress, as the exposition at Milan of 1881 of Italian industrial art clearly showed. Each has succeeded in its blown glass, in imitation of or in direct copying the best examples of the exquisite forms of the sixteenth century, in infusing it with the essential life or soul without which all art is dumb, and which speaks so eloquently in the ancient glass. With a substance that time acts on so slowly in the best examples, it is not easy to discriminate between the originals and copies. In general, however, the modern workman has yet something to learn in lightness and evenness and solidity of touch, in graceful tournure, and in those almost intangible qualities in art which come from long experience and enthusiastic passion. He has not yet wholly emancipated himself from the *role* of mere copyist. But the old genius of the Italian race for artistic invention begins to manifest itself. New forms and designs are rapidly coming into existence, rivaling in dexterity and beauty the old. I speak only of the real artistic objects made with a view of displaying the utmost skill of their best artists.

The beautiful covered chalice of the Salviati Company done by Lepoldo Bearzotti, as a specimen of exquisite enameling and original design, is a masterpiece. His copies of the Correr nuptial cup, and the famous Byzantine tazza in the treasury of San Marco, and other old pieces, leave something to desire in the completeness of their technical execution after the antique manner. It is said that eighty thousand francs have been offered for the little San Marco tazza. In the Venezia-Murano exhibition there is to be seen a copy, of the exact size of the original, done by Edwin Benvizzi for Sir William Drake, and mounted in the same manner, which cost four thousand francs, so like it that apart it is not easily to be taken as a copy. But the chief specialty of the Venezia-Murano Company is their successful reproductions of the famous antique murrhine glass, mentioned by Pliny, in imitation of fluor-spars, gems, and precious stones of transparent colors, in the form of cut and polished cups, bowls, and dishes. The old Venetians, so far as we know, did not attempt to do this on any large scale. They are costly to execute, the great bowl at the exposition being priced at five thousand francs. It is twelve and a half inches in diameter, of one piece of interblended amber and turquoise colors, and is the largest ever made. There were only two made. The uncut one I secured, and it is in the New York museum. The artist who made it says it is even richer in color than the one shown at Milan. Smaller pieces are of corresponding beauty and value, and serve to show to what perfection modern science and skill have developed this very ancient branch of glass-making. The recent imitations by the same company, and by Salviati's, of Phœnician tear and toilet bottles so closely resemble the antique ones that antiquarians may well be in despair to distinguish the new from the old, especially if the corrosions, fractures, and little marks of age have also been attempted. I showed Mr. Alexander Nesbitt a beautiful bowl of delicate blue tint, with small heads or faces interspersed in the material, recently made by the Venezia-Murano Company, so precisely like the antique Roman that, after a careful examination, he said, if a fragment of it had been brought to him in Rome, he would have sworn it was ancient glass. We may now fairly consider that the lost art of both old Rome and old Venice has been reconquered by modern enterprise, for the subtle differences that still exist in certain technical points and invention, appreciable now only on closest study, may soon entirely disappear, and Venice once more supply the marts of the world with the finest artistic glass in old and new shapes. Among her work there are now to be seen excellent reproductions of the Christian glass of the fourth and fifth centuries, found in tombs and the catacombs. These consist of dishes, cups, and goblets, with designs, in gold leaf, chiefly heads of saints, emblems, and Bible stories, embedded in the glass itself, or placed in form of medallions between two layers of different colors, which are fused together in the furnace into one compact mass.—*Italian Rambles.*

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THE most profitable industry of the new Swedish colony in Aroostook county, Maine, is that of raising potatoes for the starch factories, of which there are twenty-six. The largest of these made last year 392 tons of starch from 98,000 bushels of potatoes. The process is simple, consisting merely of grinding the potatoes, washing the pulp, and settling the starch in three vats successively after it has been thoroughly washed with clean water. Furnace heat is employed for drying.

## THE COLUMN.

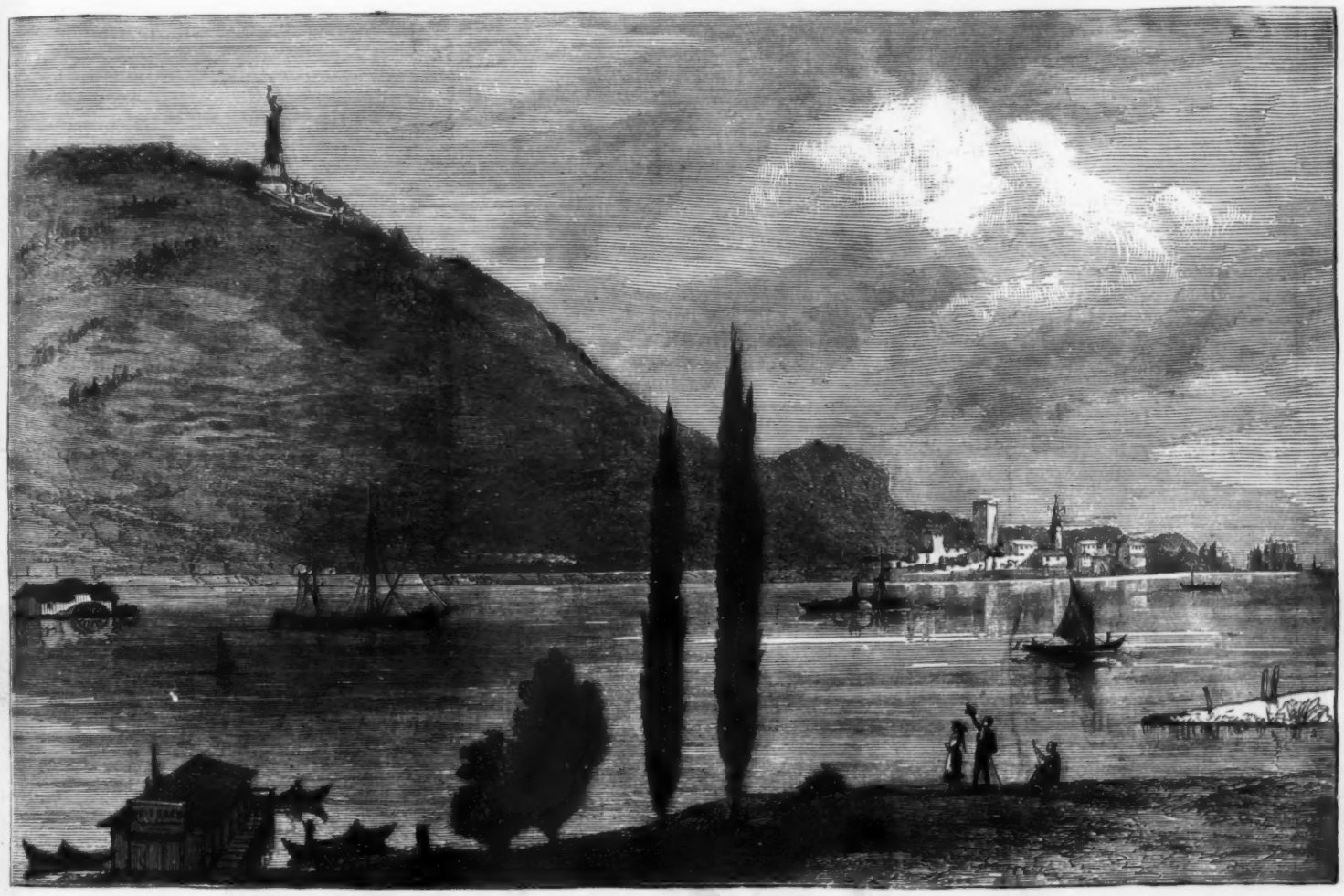
PROF. T. ROGER SMITH, F.R.I.B.A., recently opened his third session in the architectural chair at University College, Gower Street, London, by a free public lecture on "The Column," considered in its historical developments and changes. The subject was illustrated by a large number of colored and pencil drawings in perspective, elevation, section, and detail, and photographs and engravings, forming part of the collection accumulated by the successive professors at the college. The lecturer remarked that he looked upon the column as one of the elements of buildings, corresponding in character to the relations sustained by the seven notes of the scale to music and the nine parts of speech to grammar. The rudiments of architecture were six—the floors, walls, roof, openings, columns, and ornaments. Of these the first four were indispensable to the simplest building, although there were such exceptions as the perfect cell, which had no openings, and the pyramid, in which walls and roof were synonymous terms.

Columns and ornaments were non-essentials, but were present, either conjointly or separately, in the majority of buildings. What the earliest forms of columns may have been could only be conjectured, as they have passed away. Some of them must have been posts of wood, as we know they were employed at a far distant period. Others were long pieces of stone; those having the most remote antiquity in this country were still to be seen erect at Stonehenge—large squared posts of stone arranged in an ellipse, and carrying beams of the same material. Of the relative age of Stonehenge to works in other lands we knew nothing. We also surmised that piers built in masonry were in use in the most archaic times; but these have passed away. Speaking architecturally, a column might be described as a post, generally cylindrical, often of stone or marble, known as a shaft; to this essential feature was frequently added a top piece or capital, and sometimes, though not so often, a wider piece at the foot, or base.

The history of the column presented an epitome of the progress of architecture and art; this feature was the index by which we classified buildings. Its story was one of constant change; a gradual development and alteration took place in its character in each nation adopting it, until the type, which had at length become fixed for a long period, was abandoned, and a fresh series of changes were originated. These changes at one time appeared like natural growths, at other times mere freaks of fashion. The alterations were a close parallel to those which took place in architecture itself. The most ancient columns, properly so called, of which we had any knowledge, were those of Egypt, but many developments must have preceded the most archaic we saw.

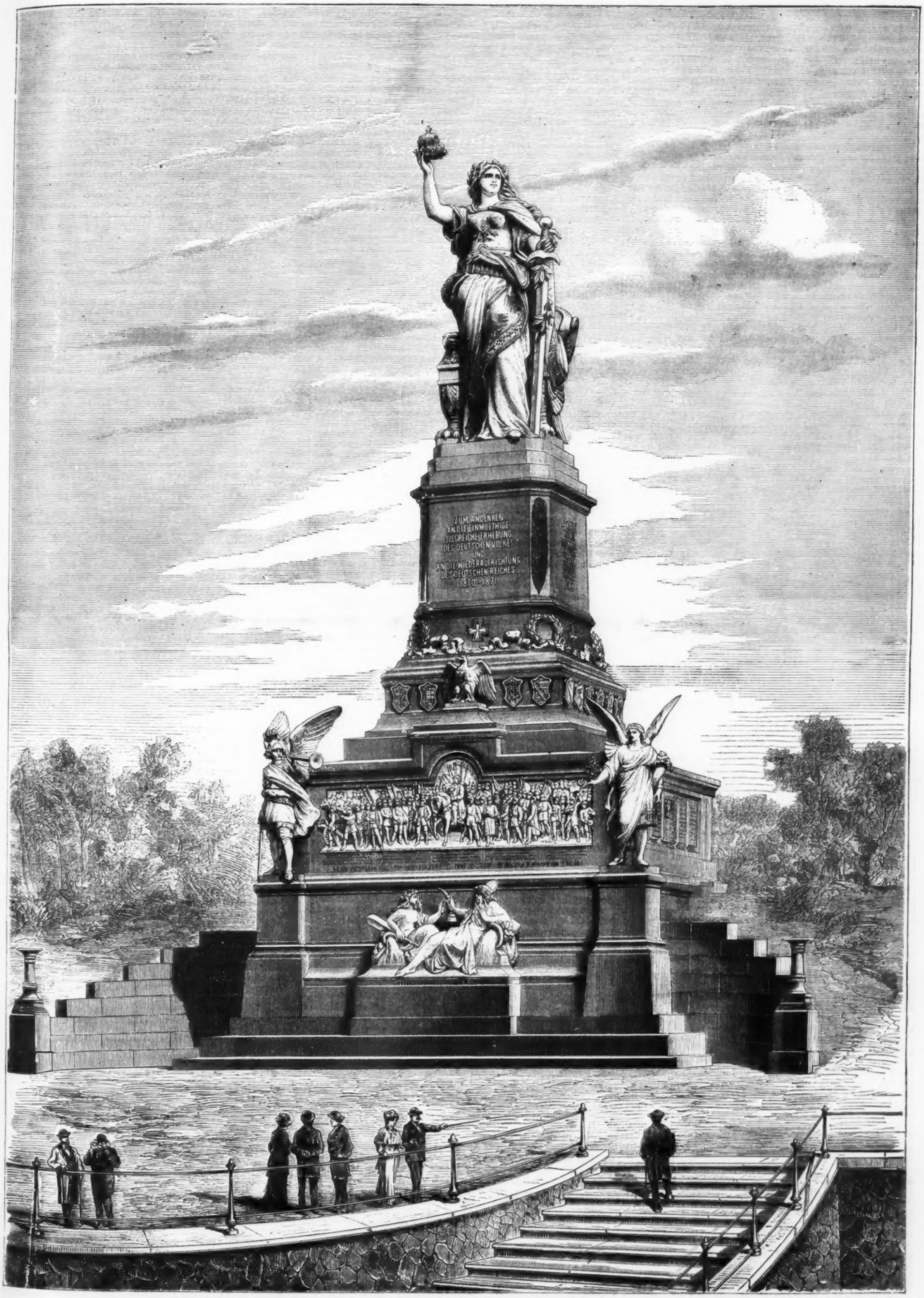
Beautiful in workmanship, elegant in design, and exceedingly carefully studied in every respect, they were evidently the outcome of a long process of development. Generally speaking, Egyptian columns were circular, massive, and often monoliths. Some were fluted or reeded, and nearly all evinced that they were designed upon a *motif* having a general resemblance to the lotus plant. Having shown by illustrations that the capital was modeled upon the bud or blossom, and that the shaft was gathered in the base, like the stem of this plant, Professor Roger Smith pointed out that there was no simple imitation or naturalesque treatment. The painted ornamentation on the column, its cap and base, followed the same rule, its suggestions being drawn from the lotus.

In Upper Egypt, as at Beni-hassan, we found another kind



THE GERMAN NATIONAL MONUMENT AS SEEN FROM BINGENBRUCK, ON THE RHINE. (See first page.)

GERMANÍA.--THE GERMAN NATIONAL MONUMENT.




THE GERMAN NATIONAL MONUMENT AS COMPLETED IN THE NIEDERWALD.

of column. Instead of swelling stem, there was simply a cylindrical shaft, fluted throughout, and bearing a square slab or abacus on the top, with a slight moulding beneath this feature. There was an evident use of this type in the Early Doric work. In later Egyptian temples, very fantastic varieties of column and capital were introduced, some with heads of the deities repeated all round. In all the abacus was a usual feature. Columns were rarely to be found outside buildings in Egypt, their use being restricted to quadrangles and halls, where they carried the roofs. In the great hall at Karnac, a space 336 ft. by 167 ft., was a series of 134 massive columns. These columns were as usual placed very near together, with slight interspaces, and were richly decorated with painted subjects. Next in point of antiquity were the columns of the Assyrians and Babylonians. We know from records and paintings that they were frequently of timber, but none remained of this material.

From the representations on bronzes brought from Nineveh, and analogy, we could form a good idea of their character. Passing on to Persia, a kingdom which much resembled Assyria, we found at Persepolis a group of extraordinary ruins, consisting of detached marble columns and doorways, still erect, and connecting these were traces of walls of sun dried bricks which had long crumbled away. These columns, unlike those of Egypt, were long and slender, sometimes fluted, and the caps were polygonal and elongated inordinately, in several tiers, divided by deep neckings; at the top were two horses placed back to back, the seat between being left apparently for wooden beams. These columns were probably petrifactions in marble of earlier timber supports, whereas those of Egypt indicated a primeval use of undressed stone. In some of these caps was a curly ornament which looked like an incipient volute to be subsequently developed in the Ionic style.

As in Egypt, the columns were exclusively used for internal decorations. He must now proceed to deal with the columns of the Greeks, probably the foremost nation that the world had produced, in architecture as well as all the arts. Their architecture began to assume shape about 700 years B.C., when they made free use of the suggestions offered by Egyptian, Assyrian, Persian, and Phœnician builders. We had abundant proofs of their indebtedness for *motifs* to these nations, although of Phœnician work we know nothing directly. Greek architecture soon subdivided into two great classes, the Doric and the Ionian. The former was chiefly practiced in Greece proper. Characterized by robustness and solidity, it was based on the work of Benibassan; the column had a circular shaft, often fluted, with square stone or abacus above; the junction of this abacus with the shaft being marked by a swelling over and contraction of the latter just below the meeting point.

The Ionic column had its development more in Asia Minor, and resulted from Oriental precedents, and, with considerable alterations, followed the type of those seen at Nineveh and Persepolis. Probably there were some nearer approaches to Ionic work in those cities than now remained, and certain representations of Ninevite slabs indicated what was afterward treated in a more refined and delicate manner in Asia Minor. Returning to a consideration of the Doric column, the earliest extant example was to be seen in a temple at Corinth; the shaft was very stumpy, and had flutes and channels upon it; above a swelling cap was a square and plain abacus with fillets under it. When they looked from this to the columns adorning the Parthenon, they found the same general treatment, but refined and rendered more artistic and beautiful. The proportion of height to diameter was in the Corinth example 4 to 1, but in the Parthenon 5·56 to 1, and in extreme instances the height equaled six diameters.

Lest they should appear topheavy, the later Doric columns always tapered from base to cap, and a more subtle correction was introduced. If columns were straight from end to end, the Greeks noticed that they appeared hollow when viewed from a distance, and accordingly a slight swelling or entasis was given. In the Parthenon columns this only amounted to ¾ in. in a height of 30 ft., but was quite sufficient to correct the apparent weakness in the center. In Doric, no plant-forms were copied; the suggestion was always that of a stone structure, although traces of wooden origin were to be seen in the entablature and other parts of a Greek temple. The columns were always fluted. To give variety, square piers, antæ, or pilasters were placed against the walls; but these were quite dissimilar to the columns, and in contrast with them. The interspaces between columns were greater than in Egypt. The Ionic column, to which he must now revert, was more slender in proportions than the Doric, nine diameters high, and always had a base—in some cases of a complicated character. Its distinctive feature was two curling ornaments, or "volutes," a decoration seemingly derived from Ninevite or late Persian examples, and never overshadowed, even although the order itself underwent development and was renamed. The flutings were more numerous, and of a different character to those on Doric columns.

The capital varied extremely, and in the best examples, as in the Erechtheum Temple, exhibited great refinement in its spiral forms; the abacus was still square, but moulded. An ornament derived from the honeysuckle, and evidently inspired by Assyrian examples, was now introduced, this being the commencement of the foliage which afterward became so luxuriant. In Asia Minor the bases had very great complexity. An example was shown from the temple at Priene, which Prof. Smith said he could not regard as otherwise than ugly. A variety of Ionic columns, called in ancient books the *columnæ ostiales*, had long been a puzzle to modern commentators, until Mr. J. T. Wood discovered an example during his excavations at Ephesus. It was a drum entirely surrounded by a group of statuary. The lowest group was rather larger than life size, and they gradually diminished in the higher planes of carving. The drum might be seen in the Greek sculpture gallery at the British Museum and would well repay examination and study.

A third division of Greek columns, arising out of the Ionic, of which it was but an elaboration, was that known as the Corinthian. The proportions were still more slender, the height being about 10 diameters. The rebates remained, but had shrunk in size, and the ornamentation, formerly adhering flatly to the shaft, now detached itself in two rows of magnificent leaves, so arranged that the tufts of the upper row were placed above the spaces in the lower range. This foliage, derived from the acanthus, but systematized and rendered suitable to its purpose, sometimes overpowered the other portions of the composition. The capital itself was tall, and the abacus was moulded and hollow. A typical example was the Choragic Monument of Lysicrates. All these classes of columns described were used to carry superstructures of beams, and were usually placed outside; we had reason to suppose that in some cases of internal treatment two ranges of columns were placed one above the other; but no examples remained. The external columns occupied the entire height of building, of which they formed the real architecture.

He had spoken of these at length, as they were the most perfect conceptions of the kind, and each was the parent of the columns employed in Western architecture for all subsequent time, while their influence extended far east through Asia. The Romans were the next great building people. They retained the three varieties of columns used by the Greeks, and added two others—very plain and commonplace Doric which they called Tuscan, and a more elaborate and clumsy Corinthian, known as Composite. They were a heavy handed race, fond of ostentatious show, and in their hands every Greek feature was vulgarized. The outlines and mouldings were coarser, no entasis or other refinements were introduced, the foliage was more abundant and less delicate, volutes were simpler curves, and although the column was more slender, the whole effect was less satisfactory. The most important alteration was that the column became non-structural. It was stuck up in front of a pier, with no function to perform, or carried an arch. The flat anta or pilaster was now a favorite feature, and columns were superposed.

Their love of display led to an illogical but magnificent employment of the column as an isolated feature forming a lofty monument. The shaft was covered with winding lines of sculpture, and above the cap was a wide stage and platform, and then, after an awkward break in the lines, a statue finished the composition. The relievos on the spiral panels afforded us vivid and highly valuable pictures of Roman costumes, weapons, and habits, but as a work of art the whole monument was open to criticism. At the Renaissance, Wren and others adopted the column as a feature of display; but in every case the problem of finishing off the summit satisfactorily was found very difficult. A monumental column could only be regarded as a splendid mistake. The Romans also used the column more rationally in the interior quadrangles of their houses, known as the peristyles, and a visit to the Pompeian court at the Crystal Palace would show how effectively this could be treated. In Early Christian architecture, columns were largely employed internally, but never externally. The shafts were frequently of marble plundered from earlier structures, then in ruins, and where new capitals were used they were adopted from Roman models. This style developed into Romanesque, and now a new principle of proportioning was introduced, which influenced all the subsequent Gothic work, and marked a most important change in mode of use.

Till now, the height had always been fixed by the diameter, of which it was a stated number of multiples; given a fragmentary drum and the order, the height could be estimated precisely. The Romanesque architects took a new view of proportioning, and arranged the diameter of a column to correspond, not with its height, but with the load to be carried. Thus, if one column carried a heavy arch, and the ones on either side were used for mere decoration, although all three were one height, the central one would be massive, and the others slender. This proportion to load revolutionized the form of the column, until in Gothic art we constantly saw internal shafts carried the whole height of a lofty building, but kept very slender, and ending in a web of vaulting ribs, or short and stout ones in window recesses.

The capital became the feature which showed the development of style. In the 12th century it was massive, with uniformly square abacus, the type being derived and debased from the Corinthian. In the next century the capitals were usually moulded with great refinement, and where foliage was introduced it grew upward toward the abacus in tufts. In the following century, the 14th, the foliage was conventionalized and curling, and was arranged as a mere wreath round the cap. In the 15th century, the foliage, which had grown more naturalesque, was discontinued; the cap and base became polygonal, the treatment stiff and mechanical, and the mouldings quite meager. In conclusion, the lecturer briefly alluded to the degeneration which marked the Renaissance period, and referred to the difficulties imposed on the modern architect by the use of so strong a material as iron, which was most difficult to employ satisfactorily on account of the slender proportions required and the light trusses which accompanied it.

## ACTION OF A DIAMOND IN RULING LINES ON GLASS.

AT the recent meeting of the American Society of Microscopists, Prof. Rogers at the outset paid this high compliment to a contemporary: "In offering this communication upon the subject indicated by the title of this paper, I am not unmindful of the fact that I enter a field in which I acknowledge a master. Since the death of the incomparable Nobert, Mr. Fasoldt of Albany stands easily first in the art of fine ruling. . . . I have thought it better to confine my attention to another equally important problem, viz.: an attempt to obtain correct copies of the Imperial Yard and Meter des Archives, at the temperature at which they are standard, to subdivide these units into aliquot parts, and thus to obtain a microscopic unit whose subdivisions should be so nearly equal that the microscope would fail to reveal the difference. The first part of this work has been nearly completed. . . . The subdivision of these units into aliquot parts—the yard into inches and the meter into centimeters—has been so far completed that any errors which may remain will not affect the microscopical unit sought. With regard to the exact subdivision of the latter unit, I can only report progress." The author's theory regarding the method which Nobert may possibly have employed in the production of his test plate was briefly stated thus:

"When a diamond is ground to a knife edge, this edge is still made of separate crystals, though we may not be able to see them, and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife edge has been obtained, the preparation for ruling consists in finding a good crystal. . . . When a diamond has been so adjusted as to yield lines of the best character, its ruling qualities improve with use. If Nobert had any so-called secret, I believe this to have been its substance."

The problem of fine ruling consists of two parts: "First in tracing of varying degrees of fineness; and second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill." The most marked characteristics of lines of good quality ruled on glass were stated thus: "A perfect line is densely black, with at least one edge sharply defined. Both edges are perfectly smooth; add to these characteristics a rich, black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. In the study of the action of a diamond in producing a breaking fracture in glass, the microscope seems to be of little service, but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling diamond. Without doubt this is the way in which lines are generally formed. But it is not the only way in which they can be produced. An examination under the microscope will reveal the fact that, in some instances at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in windrows beside the ruled line, as a plow turns up a furrow of soil. . . . The particles of glass removed take one of four characteristic forms: (*a*) They appear as chips scattered over the surface of the glass. (*b*) They appear as particles so minute that when laid upon a windrow and forming an apparent line they cannot be separated under the microscope. (*c*) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken. (*d*) They take a circular form. . . . It must not, however, be supposed that lines of the best quality always present the appearance described above."

Mr. Fasoldt's claim that he has succeeded in ruling one million lines to the inch received attention. Concerning it Prof. Rogers said: "It is only fair to say that until recently I have shared in the general incredulity with which Mr. Fasoldt's claim has been regarded. Indeed, I still think he has placed the limit just a trifle too high. But if the limit is reduced one-half, I am by no means sure but that it may be reached." After a discussion of the subject of the resolution of lines, this test was proposed:

"Let us then have a test which will for ever set at rest this vexed question of resolution. I submit for your consideration the following outline of a test which I venture to think will be sufficient and conclusive: Let Mr. Fasoldt rule three plates under as nearly the same conditions as possible, except in the number of lines in the different bands of each plate. Let him label each plate and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this sort, such as Prof. H. L. Smith of Geneva, or Col. J. J. Woodward of Washington. Let whoever receives the plates remove the labels of Mr. Fasoldt and put in their place labels whose signification is known only to himself. Then let the gentlemen who think they have resolved 152,000 lines to the inch take the plates, make their count of the lines in each band, and send in their report. Let the plates also be photographed, and let the number of lines be counted; then let the results of these investigations be published. If all substantially agree in the count, this will end further discussion."

## CLEANING AND POLISHING SILVER WARE.

THE innumerable substances used to clean silver ware can be divided into two distinct groups. One of these, says the *Metallarbeiter*, includes such as act chemically by dissolving the dirt; the other contains those which act mechanically, by attrition and friction. Among the first mentioned there are many that clean the article rapidly and well. They find extensive use in factories and large establishments, but are not suitable for domestic use as they mostly contain violent poisons.

Unless the surfaces are perfectly smooth and even without a trace of engraving or lathe-work, the use of the favorite polishing leather must be carefully avoided. In place of this it is better to use a brush with from three to five rows of bristles and of medium stiffness. The polishing material consists of chalk and aqua ammonia. [The "prepared chalk" of the druggist is better for silver than whiting.—ED.] The brush is first moistened with ammonia water and then dipped in a paste of chalk and ammonia and rubbed on the bright portions, avoiding the matte places, with gentle pressure, and in every direction, carefully going into all the corners, creases, and cavities with the point of the brush until the brush begins to get dry, and the luster comes out through the chalk. The chief thing to be attended to is to see that the chalk is all removed from these corners and crevices.

On those places that are to remain dull, or are gilded, a common tooth brush is used, which is likewise dipped in ammonia, and then rubbed on a piece of ordinary house soap, and finally a little chalk is put on it. These places are treated with this until they have a clean and fresh color. When all the spots have disappeared, it is all carefully washed with clean warm water until all the chalk and ammonia have been removed, dried carefully with old linen (not cotton), to remove all traces of moisture, and then brushed over once more with the same brush, which is dry by this time, and without putting on any more chalk. In this final polishing take care that there is not too much chalk on the brush; on hitting it against the edge of the table it should scarcely give off any perceptible dust. Too much chalk injures the luster.

To produce the "black luster" a leather file is made by gluing a strip of chamois or wash leather an inch wide on a strong piece of wood, and putting some ignited lampblack (to be had of druggists) mixed with alcohol on the leather side. The brightest places are polished with this, which gives them the favorite luster of polished silver or steel.

The cause of silver tarnishing is due chiefly to the sulphureted hydrogen in the air, which produces a little sulphide of silver that forms yellow and black spots. The ammonia dissolves the trace of sulphide, and the spots vanish. The polishing is done by the friction of the chalk, which makes it shine.

In polishing ornaments made of matte silver the same process is employed as above described for the dull portions of silver ware. They are washed in hot water containing sal soda, and rubbed with soap on a tooth brush and finally dried in saw dust.

## MALLEABLE BRONZE.

IN order to prepare a bronze that shall be as elastic as copper or wrought iron, says the *Polytechnisches Notizblatt*, some mercury must be put in it, say from 1 to 2 per cent. according to the degree of malleability to be imparted to it.

The mercury may be combined with one of the metals of which the bronze is made before making the alloy, or it may be added to the melted mass that already contains the different metals in the proper proportions. Thus it can be added to the melted copper before or after the addition of tin or simultaneously with it, and stirred; or an amalgam of tin can be introduced into the melted copper.

## STARCH AND THE TRANSFORMATIONS INDUCED BY ORGANIC AND OTHER ACIDS.

By F. SALOMON.

For the past five years the author has been investigating these changes, and the results obtained were frequently so contradictory and so at variance with all his expectations that he was often on the point of giving up the whole work, especially when Soxhlet showed that Fehling's test was still inaccurate, for this invalidated whole series of experiments.

The author, therefore, directed his entire attention to accurately establishing the prominent analytical characteristics. He then examined the starting point and end products, starch and dextrose; subsequently the intermediate products, such as soluble starch, dextrose, and maltose. The careful determination of the elementary composition of potato starch [$C_6H_{10}O_5$ or $X(C_6H_{10}O_5)$] and the quantity of sugar produced by its complete conversion with acids (namely, 111·11 per cent. of dextrose or starch sugar), as well as the elementary composition of rice starch and its quantitative estimation, have already been published in the *Chemiker Zeitung*, vi., 678 and 1,253. A general survey of the whole field and summary of the results are now given.

### STARCH.

Allihn has shown (*J. Prac. Chem.*, xxii., 50), by very careful study of the process of saccharification, that under those conditions which generally prevail in starch analyses, only 95 per cent. of the starch is converted into sugar. Salomon also found that the conversion with sulphuric acid is totally useless for analytical purposes. But he gives another process of saccharification whereby *all* the starch can be converted into dextrose and the theoretical quantity obtained. The latter process was devised by Sachse (*Chemisches Centralblatt*, 1877, 732). He makes use of hydrochloric acid in the following proportions: From 2½ to 3 grammes of starch are dried at 120° C. (100° to 110° will not suffice) and placed in a flask with 200 c. c. water and 20 c. c. of hydrochloric acid having a density of 1·125. It is heated for three hours with a return cooler (an upright tube 40 to 60 inches long will answer) on a water bath or in boiling water. At the close of this reaction a colorless liquid is obtained in which there are only a few white flocks, consisting chiefly of the remains of cell membranes. If this insoluble residue is to be determined, it is collected upon Soxhlet's asbestos filter, carefully washed, dried at 100° C., and weighed. The different filtrates are united and carefully neutralized with potassic hydrate.

The sugar is then estimated gravimetrically as follows: 60 c. c. of an alkaline copper solution (equal volumes of Rochelle salts and sulphate of copper solutions) are put in a beaker glass having a capacity of 300 c. c., diluted with 60 c. c. of water, and heated to boiling over an open flame or on a sand bath. From a pipette he runs 25 c. c. of sugar solution (with not more than 1 per cent. of sugar) into the boiling copper solution, boils again, and immediately filters out the suboxide of copper reduced. He uses for the purpose an asbestos filter made by drawing out a piece of combustion tubing 4 inches long to half its size, and filling the broader portion one-fourth with long fibers of freshly ignited asbestos. It is advisable to put a plug of glass wool (spun glass) below the asbestos to prevent any particles being carried through; the asbestos must not be packed in too firmly nor left too loosely. When filtering, a small funnel is placed on top and the apparatus connected with an aspirator. After decanting several times, the suboxide of copper is thrown on a filter and washed with water and then rinsed with alcohol and ether to hasten the operation of drying, which is done in an air bath. The oxide is reduced to metallic copper in the filtering tube by placing it in an inclined position over the point of a flame and passing dry hydrogen gas through it. The reduction is completed in a few minutes at a moderate heat. The operation is finished when the precipitate exhibits the characteristic color of copper and no little drops of water form in the cool end of the tube. It is cooled in the hydrogen current and then placed in a desiccator.

The following estimations are necessary for an accurate and complete analysis of starch, viz.:

Estimation of the moisture in it; of the non-combustible constituents (ash); the quantitative determination of the substances insoluble in dilute acids, such as cellulose, nitrogenized substances, etc.; also the conversion into sugar by acid and the estimation of the latter.

### DEXTROSE.

Dextrose is also known as grape sugar and starch sugar (also glucose). The author ascertained by very carefully controlled experiments on the elementary composition of starch, that the mean specific gravity of a 10 per cent. solution of sugar (10 grains in 100 c. c.) at 17½° C. was 1·0381. From this he constructed a table for finding the number of grammes of anhydrous dextrose in 100 c. c. of any aqueous solution from its specific gravity at that temperature.

[We omit the table, which may be found in the *Chemiker Zeitung*, No. 74, p. 1194, as it can be easily constructed by any who need to consult it frequently.—TRANS.]

The table gives the number of *grammes* of sugar in 100 *cubic centimeters* of any solution; to find the number of grammes in 100 *grammes* of solution, the readings must be multiplied by the specific gravity of the solution.

In regard to the reducing power of dextrose for copper solutions, Soxhlet had already shown (*J. Prac. Chem.*, xxi., 227) that every kind of sugar examined, such as inverted sugar, grape and milk sugar, lactose and maltose, possessed a different reducing power, and that there was no constant reducing relation between copper and sugar, but that it varies with the concentration and is dependent upon the quantity of copper in the solution. The gravimetric method already so fully described in this article gives results that can be depended upon when no other substance is present except grape sugar. The method is absolutely accurate when the amount of sugar in solution is very near 1 per cent. If the dextrose is mixed with other substances, even if they are not of themselves reducing, they will sometimes increase the reducing power on long heating.

The optical action of aqueous solutions of dextrose has been very thoroughly investigated by Tollens, who found that the specific rotatory power of anhydrous grape sugar when in moderately concentrated solutions (5 to 14 per cent.) was = 53·1° for the D line. Salomon found D = 52·7°, and the rotatory power of aqueous solutions approaching 10 grammes in 100 c. c., in 200 mm. tube at 17½° C., was j= 58·68°, while Brown and Heron found 58·65, and Tollens 59·1 for the same.

The characteristics of dextrose may be stated to be that it dissolves readily in water and dilute alcohol; aqueous solution of iodine causes no perceptible change in solutions of this sugar; the specific gravity of a solution containing 10 grammes in 100 c. c, is 1·0381; the reducing power is estimated by Allihn's process; the specific rotatory power for polarized light is $\alpha$ j (alpha j) = 58·68°; or 1 gramme of dextrose in a 200 mm. tube of the Soliel-Ventzke-Scheibler, or of the sensitive Jellet-Cornu half-shadow polariscope causes a deviation of 3·06 S. V. S. or J. C.

### MALTOSE.

This substance was first isolated by Saussure, in 1819, and was examined and named by Dubrunfaut, in 1847. It lay forgotten until O'Sullivan brought it to light again in 1872–6. Recently Brown and Heron (*Am. Chem. Pharm.*, cxcix., 201) invested it again, and then Soxhlet and Meissl (*J. Prac. Chem.*, xxv., 119) also took up its study.

Maltose is very soluble in cold water and in hot, acts like a real sugar, and when air dried has this composition: $C_{12}H_{22}O_{11} + H_2O$. Dried at 100° C., *in vacuo*, it becomes anhydrous and has the composition $C_{12}H_{22}O_{11}$. The aqueous solution of maltose gives no color with iodine solution, and no precipitate with strong alcohol. Brown and Heron state that the specific gravity of a solution containing 10 grammes of anhydrous maltose in 100 c. c. is 1·0393 at 15½° C. Salomon constructed a table based on Meisel's results to find the quantity of maltose in any solution at 17½° C. [Table omitted.]

The rotation of 1 gramme of maltose in 100 c. c. of solution in a 200 mm. tube, according to Meissl, in Jellet-Cornu apparatus is calculated to be 8°. Soxhlet puts the reducing power of maltose in 1 per cent. solution at 113 copper for 100 of anhydrous maltose with 4 minutes' boiling; Salomon observed 116 of copper.

*Characteristic properties of maltose.*—It is soluble in water and strong alcohol; gives no reaction with iodine; the specific gravity of 10 grammes solution of anhydrous maltose in 100 c. c. at 17½ C°. is 1·0390; 1 gramme of anhydrous maltose in 100 c.c. solution rotates the light 8°; and 1 gramme reduces 1·13 of copper.

### SOLUBLE STARCH.

This was first described in 1840 by Jaquelin. It is obtained as follows: 100 grammes of potato starch are stirred up with 5 grammes of sulphuric acid in 1 liter of water, and kept boiling for 2½ hours on a salt-water bath. When cold it gives a reddish purple color with iodine. The solution is then saturated with barium carbonate, filtered, evaporated down a little, then precipitated with alcohol, and the precipitate dissolved in water, reprecipitated, and, after dissolving again, the solution is evaporated to a sirup. The white powder is repeatedly washed with water, alcohol, and ether, and dried at 105 C°. This soluble starch is nearly insoluble in cold water, but dissolves with ease in hot water, forming a clear, transparent (not pasty) solution. In dilute solutions alcohol throws down a permanent precipitate; the following day nearly all is precipitated in form of powder. If the alcohol is not skillfully added, a slimy, stringy mess is precipitated. Upon adding a solution of iodine to a solution of the pure substance, a beautiful deep blue clear liquid is obtained; the presence of dextrine affects the color. It does not reduce the copper solution. One gramme of the substance caused a rotation of polarized light 11·01° in J. C. or S. V. S. apparatus.

*Characteristics of soluble starch.*—Soluble starch in aqueous solution is turned deep blue with iodine; does not reduce copper in Allihn's method; 1 gramme of soluble starch in 100 c. c. of solution has a specific gravity of 1·00401, and turns the ray of light 11·01° in the Jellet-Cornu apparatus.

### DEXTRINE.

It is comparatively easy to prepare pure dextrine with dilute sulphuric acid if care be taken to check its action upon the starch in time. Salomon obtained a very pure dextrine which gave only a red color with iodine by simply pouring off the solution obtained in the preparation of soluble starch as above described, and which gave a deep red-brown color, from the precipitated starch. This liquid, which contained the dextrine, gave with iodine a pure brown color. The dextrine was precipitated with alcohol, and obtained as a tenacious mass by evaporating aqueous solution on a water-bath. After standing a long time over sulphuric acid *in vacuo* it became hard, vitreous, and brittle, so that it was easily rubbed to an impalpable powder; it dissolves easily both in hot and cold water. The one per cent. solution did not reduce any copper by Allihn's sugar method. The action of dextrine with iodine is very unreliable. A solution of dextrine in water gave at first a brownish-red color which disappeared immediately, and did not become permanent until the reagent had been repeatedly added, and is perhaps to be attributed to a slight residue of soluble starch. A solution containing 1 gramme of dextrine in 100 c. c. has a specific gravity of 1·0040. The specific rotatory power of this substance, according to the observations of Brown and Heron, corresponds to $\alpha j = 216°$, or according to Salomon 216⅓°, so that one gramme of dextrine in 100 c. c. solution in a 200 mm. tube rotates the light 11·3° J. C.

The important analytical elements of dextrine are the following: Fehling's solution is *not* reduced by dextrine with Allihn's method of testing; it is precipitated by alcoholic from aqueous solution; it gives no color with iodine solution; its specific rotatory power is $\alpha j = 216⅓°$. The rotatory power seems to be higher in acid solutions than in neutral.

The second portion of Salomon's paper relates to the action of sulphuric acid of different degrees of concentration upon rice starch. The third portion is more important, and relates to the saccharifying process. The final results of these investigations may be summarized as follows:

### RESULTS.

We are in possession of all the data necessary for the detection and estimation of starch, dextrose, and maltose, and they rest upon a solid basis. Dextrine and "soluble starch" require further investigation, since the characters that are indispensable for recognizing them with certainty are dependent on so few experiments.

The conversion of starch into sugar by dilute sulphuric acid is not to be considered as a splitting up of the molecule into sugar and dextrine, as Musculus assumed in his day, but rests, as Payen showed, upon a gradual change. The experience gained during the course of the investigation led him to think that the process goes on as follows: The first action of the sulphuric acid is the conversion of the starch molecule, which probably consists of several $C_6H_{10}O_5$ groups, into soluble starch, which has a more simply constituted molecule, and this into the still simpler dextrine. This change takes place with uncommon rapidity, so that the second phase of the process, the hydrating of the dextrine, which converts it into sugar, begins almost simultaneously with the other operations. As the saccharification is intimately related to the time and the strength of acid used, so that twice as much acid will convert twice as much dextrine into sugar in the same time, we may look up the operation as very similar to that of making ether.

### SACCHARIFICATION—ETHERIFICATION.

The sulphuric acid unites with a definite quantity of dextrine, hydrates the same, and then leaves it again, to unite at once with a new quantity of dextrine and convert that into sugar in the same way, and so on. By doubling the quantity of sulphuric acid the operation goes on twice as fast, *i. e.*, twice as much dextrine is converted into sugar in a unit of time. By doubling the quantity of starch the process is delayed to the same extent, because the amount of work that the acid has to do is twice as great. It is perhaps totally unnecessary to assume an intermediate stage corresponding to the ethyl-sulphuric acid, since the whole process consists to a certain extent of a slow combustion attended with loss of energy.

The substances formed by the action of dilute sulphuric acid upon starch are the following, and in the following order: soluble starch, dextrine, dextrose.

### ORGANIC ACIDS.

In the conversion of starch into sugar by means of organic acids, it passes through the same stages as above described. The organic acids, such as oxalic, tartaric, and citric, act much more feebly, but yield no other products besides soluble starch, dextrine, and dextrose.

Finally, the author expresses the opinion that it would be of great practical value to extend the methods employed in this investigation to the study of the action of diastatic ferments upon starches, and that Brown and Heron's essay offers a valuable starting point.—*Jour. Pract. Chemie.*

## ON THE PREPARATION OF CERIUM OXIDE.

By M. H. DEBRAY.

FIVE hundred grammes of cerite, finely powdered, are stirred up in, at most, an equal weight of water, and 375 grammes of concentrated sulphuric acid are added while the mixture is being rapidly stirred. This operation is performed in a large platinum capsule with a flat bottom. The mixture becomes hot, swells up, and is rapidly converted into sulphate of the earths of cerite, and into gelatinous silica. The whole is evaporated until dense fumes of sulphuric acid begin to appear, stirring all the time to prevent the mass from adhering to the bottom of the capsule. The matter is then pulverulent, and the silica has become insoluble. When it is quite cold, it is thrown, little by little, into water kept at 0° by means of ice (5 or 6 liters at least); the sulphates, which are slightly acid, dissolve readily in the water if we prevent the rise of temperature which accompanies hydration. The liquid is filtered off and treated with a current of hydrogen sulphide; when saturated with this gas, it is let digest for twenty-four hours. A complex mixture of copper, bismuth, molybdenum, etc., sulphides is deposited. The mixture is heated to cause these sulphides to be perfectly precipitated, and filtered. The rose-colored filtrate is precipitated with concentrated oxalic acid. There is formed an abundant curdy deposit, which collects at first in a soft state at the bottom of the vessel, and is rapidly converted into a crystalline powder of the acids of the cerite earths. The acid liquid contains lime and iron. The oxalates are washed by decantation and converted into nitrates by attacking them with hot concentrated nitric acid.

So far the treatment indicated does not essentially differ from that commonly adopted for extracting from cerite the mixture of earths discovered by Mosander. It is chiefly in the treatment of the nitrates for obtaining cerium oxide that the process is distinguished from those hitherto adopted for separating creoso-ceric oxide from the didymium and lanthanum oxides.

The mixture of nitrates is melted with 8 or 10 parts potassium nitrate in a porcelain capsule, and the fused mass is kept between 300° and 350° by means of a gas furnace. Cerium nitrate is decomposed, forming a yellowish powder of cerium oxide, which retains a little nitric acid, but didymium and lanthanum nitrates, when melted with niter, are not appreciably decomposed even at 350°. A thermometer, plunged into the bath of nitrate, indicates its temperature. When the escape of nitrous fumes ceases, which requires several hours, the operation is stopped. When cold the melted mass is easily detached from the capsule, and the cerium oxide is found collected at the lower part. It is dissolved in water, and there remains a powder, yellowish if it contains mere traces of didymium, but reddish if it contains more. It is well to wash with a little weak nitric acid, which dissolves a little didymium subnitrate produced at the same time as the cerium oxide if the capsule is too strongly heated at certain points. This is of little consequence, as the cerium oxide obtained in the first operation always requires to be purified.

It may be entirely freed from didymium by transforming it into nitrate, which is melted a second time with 8 or 10 parts potassium nitrate. For this purpose the oxide is attacked with sulphuric acid diluted with an equal volume of water, taken up with water when everything dissolves if the liquid is sufficiently acid. The yellow creoso-ceric sulphate thus obtained is reduced with sulphurous acid, and the cerous sulphate is precipitated with oxalic acid. The cerous oxalate is then readily converted into nitrate by boiling with nitric acid. This second treatment gives a yellow powder, which contains neither didymium nor lanthanum, as the nitrate of the latter earth is still more stable than that of didymium. If it is transformed into colorless cerous sulphate, the spectroscope does not detect the least trace of this body, which is always easy to recognize by its absorption-spectrum. The didymium and lanthanum nitrates which remain mixed with a large excess of potassium nitrate are evaporated and remelted, the temperature exceeding 350°. The remaining trace of cerium nitrate which has escaped decomposition in the former operation is completely destroyed, and there is even formed a small quantity of didymium subnitrate. But the bulk of the didymium remains with the lanthanum in the state of a soluble nitrate.

We have thus a certain and rapid method of obtaining the oxide or the salts of cerium free from didymium and lanthanum, or, on the other hand, a mixture of these two oxides absolutely free from cerium.—*Comptes Rendus.*

## CYLINDERS FOR CALICO PRINTING.

By J. DEPIERRE and PAUL SPINAL.

THE metals best suited for printing are pure copper and alloys containing from 25 to 30 of zinc to from 75 to 70 of copper. Lead, even if present to the extent of ½ per cent., is injurious. The introduction of 1 per cent. of phosphorus in brass renders the grain more homogeneous.

## STEINER BROTHERS' LARGE FLOUR MILL AT MALTERS, SWITZERLAND.

In the present article we propose to describe a fine example of a flour mill recently erected at Malters, Switzerland, for Messrs. Steiner Bros. This mill is designed for grinding 200,000 kilogrammes of wheat per week, that is to say, 330 to 340 metric quintals every 24 hours, with a hydraulic turbine capable of furnishing an effective power of 150 horses, or a work equivalent to at least that of 16 to 18 pairs of stones.

The two first figures in Plate I. give a general view of the mill in transverse and longitudinal section on a scale of $\frac{1}{150}$, and show that the building in which all the machinery is installed consists of no less than six stories, inclusive of the ground floor. On the latter the builders have placed all the large shafting and the cleaning apparatus, so as to isolate these from the other machines.

The crushing and converting cylinders are all in two parallel lines upon the floor of the first story. The upper stories contain the numerous series of flour, grits, and bran bolting machines, as well as the sifting machines, the grits cleaning machines with their chutes, and the elevators and endless screws that are used in connection with these apparatus. Fig. 3 shows in plan the series of sifting machines that are shown in front and side view in Figs. 1 and 2. Figs. 4 and 5 of Plate II. show in elevation and plan the different apparatus for cleaning wheat. Fig. 5 gives a transverse section on the line 1–2 of the plan, and shows not only these apparatus in side view, but also the large feed hopper for the grain coming to the mill, as well as the additional mills employed especially for regrinding certain products. Finally, Fig. 7 is a diagram showing in plan, and as simply as possible, the successive operations that the wheat has to undergo from first to last.

rubbed with some force. This operation has the advantage of crushing such black grain as may have passed through the preceding apparatus, and which would injure the quality of the flour were they to reach the crushers.

A dividing cylinder, G, and a vertical brush-cylinder, H, movable in a jacket of perforated sheet iron, complete the scouring. Finally, a winnowing machine, I, finishes up the work by eliminating such spoiled and light grains as may have been carried along with the good wheat. All these apparatus are placed on the ground floor, and are connected, from the first to the last, by a series of chains and buckets, $a^1$, $a^2$, $a^3$, etc.

*First Operation.* Crushing-cylinders No. I.—On making its exit from the fanning machine, I, the purified wheat is carried up to a large hopper, T' (Figs. 1 and 2, Plate I.). But, before being delivered to the crushing-cylinders, it is submitted to the action of a second magnetic iron-extractor, so that, when it finally does reach the two double crushers, J, or rough-crushing cylinders No. I, it is not only very clean, but is also freed from all foreign bodies. These first two mills, which are each mounted with two pairs of rollers or large grooved cylinders, have no other work to perform than that of opening the grain, separating its two lobes, and flattening them without producing flour.

As these cylinders number four pairs, there should pass about 6 or 7 kilogrammes of grain per hour, provided its distribution be regular. After this first operation the volume of the crushed grain is naturally so much greater that its weight no longer corresponds to but 60 kilogrammes the hectoliter. The grain thus crushed, but not pulverized, now falls through the chutes, *c*, into the lower part of the large elevator, *b*, which runs to the top of the building, and this carries it up to the first bolting mill, K. This latter removes from it but very little flour and bran, and what portion has not been able to pass through the meshes of the machine duct derived from it contains a relatively larger amount of flour and grits. And its volume, likewise, in this second operation becomes so increased that the weight of a hectoliter before bolting is now no more than 42 to 43 kilogrammes. All this material is carried by the chute, *c'*, to the bottom of the elevator, *b'*, and is raised by this to the top floor and emptied into the bolting machine, K', which separates the flour from the grits. All that portion which has traversed the meshes of the bolting cloth falls upon an endless screw, *e'*, (Fig. 2), while the rest issues from the extremity and is carried by a chute into a third compartment connected with the hopper, T'. The endless screw, *e'*, carries all the fine portions to the bolting machine, L'. The flour separated by this latter falls into the first four boxes and is at once put into bags, while the fine grits enter the last box, whence they are sent to a third bolting machine, N, in the lower story (Figs. 1 and 2). The products divided by this machine are put into bags separately in order to be carried, each in its turn, to a second special sifting machine, Y, showed in plan in Fig. 7.

The grits that have not traversed the cloth of the machine, N, make their exit from the extremity and fall to the bottom of an elevator, *h*, which, running to the top story, carries them to the assorting cylinder, O. This latter likewise receives the grits that have been collected in the last box of the upper bolting machine, $K^1$. This assorting cylinder is nothing more than an ordinary cylinder whose silk is arranged for classifying the grits according to size, so as to distribute them separately among the sifting machines, S, $S^1$, $S^2$, that are to clean them (Figs. 2, 3, and 7).

*Third Operation.* Crushing-cylinders No. III.—Crushers No. III. ($J^2$), placed in the same story and in a line with those that have just been mentioned, receive from the third compartment of the hopper, $T^1$, the material derived from the extremity of the bolting machine, $K^1$. This pro-

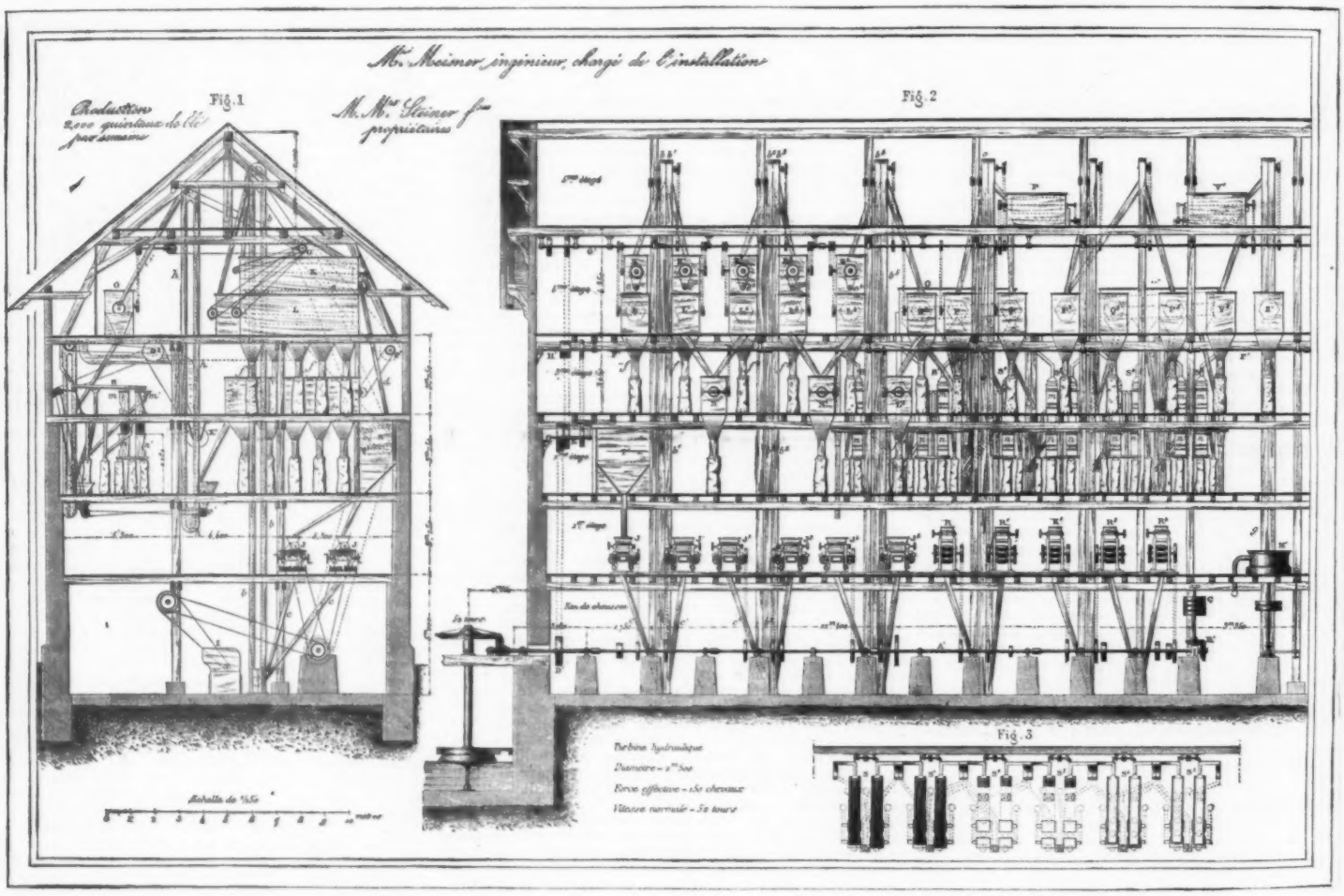



PLATE I.—DETAILS OF FLOUR MILL AT MALTERS, SWITZERLAND.

*Cleaning Apparatus* (Plate II., Figs. 4, 5, and 6).—The grain, as shipped from Hungary, is brought to the mill by cars, W, running on rails laid parallel with the side of the building and at a sufficient elevation to allow the grain to be emptied upon the floor of the first story directly over the large hopper, T, which extends from the ceiling to the floor of the basement. At the upper part of the inclined plane that forms the bottom of this hopper, there is an endless screw, *v*, which receives at several points along its length the quantity of grain desired for regularly feeding the mill, say, for example, 1,500 or 1,600 kilogrammes per hour, or 25 to 26 per minute to correspond to a regular grinding of 320 to 350 metric quintals of wheat per day. An elevator or chain and buckets, *a*, puts this endless screw in communication with a magnetic apparatus designed for separating such nails or particles of iron as might be mixed with the grain. This apparatus is directly mounted upon the fanning machine, A, which serves at the same time as a smut mill. From this fanning or winnowing machine the grain is raised and emptied into a sifting cylinder, B, which separates the poor grains and especially those of very small size which would yield nothing but inferior flour. Two assorting machines, C, come next, and eliminate such round seeds as have passed with the wheat through the apertures in the sifting cylinder. From these assorting machines the wheat is sent to the scouring machine, properly so called, D, which consists of a vertical cylinder provided internally with steel wires, and in which revolve with great rapidity a series of fans that remove from the grain all the dust that adheres to it. This dust is driven from the machine by means of a blower, and is received in a room set apart for the purpose. Two other cylinders, E, remove the heavier particles of dust that have not been expelled by the scouring machine. The cleansed grain then passes into a brushing cylinder, F, wherein it is rolled and escapes from the other extremity and is carried by the chute, *d*, into a compartment forming a prolongation of the hopper, T' (Fig. 1). At the lower part of the bolter, K, there is an endless screw, *s*, which receives the small amount of flour, bran, and grits that has traversed its meshes, and carries it to the bolting machine, L, called the flour bolter, whose purpose is to separate these products. These latter are then at once put into bags by means of bagging machines, *f*, placed beneath boxes fixed to the bottom of the bolting machine. The first of these boxes gives flour, which remains in bags if it be not desired to mix it with that derived from the other crushings. The products from the other boxes, consisting of grits and unscoured bran, are carried to a special mill, M, on the first floor, as shown in the general plan (Fig. 5, Pl. II.) The product from this mill is then carried to a special flour bolting machine, V (Fig. 7), and, after it has been acted upon by this, the flour that has been separated is put into bags, while the grits and bran that issue from the end are returned to the mill. Those portions that have not been able to traverse the cloth of the first bolting machine, L, make their exit from its extremity and are sent, before being returned to the mill, to a special sifting machine, X (Fig. 7).

*Second Operation.* Crushing-cylinders No. II.—The crushed wheat coming from the extremity of the first bolting machine, K, is carried by the chute, *d* (Fig. 1), into the second compartment of the hopper, T'. Being freed from the particles of flour, grits, and bran, it weighs about 62 kilogrammes the hectoliter. In this state it is distributed over two pairs of crushing cylinders, J', which do not perceptibly differ in construction from the ones before mentioned (J), although their table is longer and their grooves are finer and closer together, and the rollers themselves are nearer each other. The grain is then crushed anew, ground, and divided into a larger number of particles. Consequently, the product is submitted to the action of rollers that are close together and have finer grooves, in order to be again crushed. This gives, as the material comes from the cylinders, a large quantity of flour, grits of different sizes, and bran of varying coarseness, which must be separated as was done with the former products.

Falling through the chute, $c^2$ (Fig. 2), to the bottom of the elevator, $b^2$, this mixture, which after trituration weighs scarcely more than 37 to 38 kilogrammes to the hectoliter, is carried to the upper story to be emptied into a bolting machine, $K^2$, which differs from the ones before mentioned only in the size of the meshes of its bolting cloth. All that passes through this latter is carried by the endless screw, $e^2$, into the lower bolting machine, $L^2$, in order to effect a separation of the flour; and this having been done, the latter is at once put into bags by the machine, $F^2$. The remaining grits, like those derived from the machine, $L^1$, are put into the fine grits bolting machine, N, and, upon coming from this, are put into bags in order to be carried to the special sifter, V (Fig. 7), while the coarser grits that emerge from the extremity are sent to the assorting cylinder, O, in order to be separated, and distributed in the sifting machines S, $S^1$, and $S^2$. During this time, the material coming from the extremity of the bolting machine, $K^2$, is directed into the fourth compartment of the hopper, $T^1$, in order to undergo the

*Fourth Operation.* Crushing-cylinders No. IV.—The material, being freed from the flour and disintegrated grits, becomes notably lighter, its volume being such that a hectoliter of it weighs scarcely 30 kilogrammes. Yet, when it comes to be passed through the cylinders, $J^3$ (or crushers No. IV.), whose grooves are very fine, there is still a certain amount of flour and grits yielded by it, and these products are then separated, as before, by means of

the bolting machine, $K^3$, and the flour bolting machine, $L^3$. Immediately beneath this latter there are bagging machines, $F^3$, which put the flour into bags, while the grits are sent to another fine grit bolting machine, $N^1$, (Fig. 2). These grits are likewise put into bags to be sent to the second sifting machine, Y (Fig. 7). The rejections, consisting of slightly coarser grits, escape from the end of the bolting machine, $N^1$, and are sent, along with those from the last box of the bolting machine, $K^3$, to an assorting cylinder, O (Figs. 2 and 7), by means of endless screw, $e^1$, and an elevator similar to the one before mentioned (*h*). Here they are classified according to size, and distributed among the sieves, $S^3$, $S^4$, and $S^5$.

*Fifth Operation.* Crushing-cylinders No. V.—As in the preceding operations, the material which has not passed through the cloth of the machine, $K^3$, escapes from the extremity and goes to the fifth compartment of the hopper, $T^1$, and from thence to the cylinders, $J^4$ (or crushers No. V.), in order to be again crushed. The operation is performed in absolutely the same way, that is to say, the crushed product is carried to a grits bolting machine, $K^4$ (like the others), which sends the flour, through the intermedium of a screw, $e^4$, to the lower bolting machine, $L^4$, from whence, as the flour issues, it is put into bags, while the fine grits, along with those from the bolting machine, $L^3$, go to the machine, $N^1$, and afterward to the sifter, Y (Fig. 7). The rejections are taken up to the assorting machine, $O^1$, in order to be distributed, as before, among the sieves, $S^3$, $S^4$, and $S^5$.

*Sixth Operation.* Crushing-cylinders No. VI.—Finally, the product that escapes from the bolting machine, $K^4$, is sent to the cylinders, $J^5$ (crushers No. VI.), whose grooves are exceedingly fine, and, having been at once pulverized, is sent to the bolting machine, $K^5$, which yields flour that is at once put into bags, and residua that go to the bolting machine, $L^5$, in the lower story. Beneath this last-named *m'*, of the cleaning apparatus. Now, as each compartment receives a current of compressed air for expelling the fine bran, and as there are likewise cleaning apparatus beneath that have two compartments, *n* and *n'*, it results that the particles fall from one to the other and classify themselves automatically, upon receiving the action of the air successively, and become distributed among the bags placed immediately beneath the lower compartments.

Since the entire system embraces six double sifters, S, $S^1$, $S^2$, $S^3$, $S^4$, and $S^5$, without reckoning the two special ones, X and Y, (Fig. 3), there are really, then, 12 simple sifters each accompanied with 2 cleaners having two superposed compartments. Besides, as each sifter carries a sieve with three distinct sizes of meshes, we obtain, in sum, $12 \times 2 \times 3 = 72$ sorts of cleaned and well classified grits.

The entire system, moreover, is so arranged that when the too coarse particles have not been able to go through the sieve of one of the sifters, they are carried by an inclined chute to an elevator, which takes them up to the sifter that precedes. This essential arrangement is very interesting in that it permits all the grits to classify themselves automatically according to their size and density.

We should observe that the two assorting cylinders, O and O', each possesses three boxes for furnishing their products respectively to the two series of double sifters, as shown in the diagram in Fig. 7. But the products coming from the ends of these cylinders, being too coarse, are carried back to the crushing-rollers, $J^3$, in order to be pulverized anew.

We must also remark that the constructors have placed beneath the floor of the sifting room a large flowing machine, X', designed to drive all the dust into a special chamber on the fourth floor.

*Converting or Reducing Cylinders.*—It will be recalled that the flour obtained in the successive crushings is put into bags in measure as it comes from the flour bolters, L, $L^1$, $L^2$, $L^3$, $L^4$, and $L^5$, on the fourth floor (Figs. 1 and 2). In order to mix these flours it is only necessary to carry the bags to the end of the mill and empty them, through a small projecting hopper, into a large room set apart for the purpose.

But, as the different sorts of grits have to be converted into flour in their turn, they are submitted separately to the action of hard cylinders or porcelain rollers called "converters" or "reducers." The products furnished by the sieves of the three double sifters, S, $S^1$, and $S^2$, and which contain only white grits, are sent, according to their classification, to the two first pairs of converters, R, R' (Figs. 2 and 7), and the flour that is disengaged from them is carried up by a chain and buckets, *o*, to a special bolter, P, on the fourth floor, where it may afterward be bagged, or to a bolter on the fifth floor provided with an endless screw that empties the product into a fine grits bolter, Q. The material from this latter, consisting of fine grits, is sent to the mills, $M^2$ and $M^3$ (Figs. 5 and 7). The grist from these is naturally bolted apart in a flour bolter, V', from whence the rejections pass to the fine grits bolter, $V^2$ (Figs. 2 and 7), in order to be afterward ground anew.

The fine grits that have not traversed the cloth of the bolter, Q, are sent to the special sifter, Y (Fig. 7), which is already receiving the products emanating from the fine grits bolters, N and N'. From this sifter all the fine grits are carried to two other reducers, $R^2$ and $R^3$, in order likewise to be converted into flour. The latter, having been carried up to the top floor, is bolted in the same way by the similar bolting machines, $P^2$ and $P^3$, which put it into bags, while the rejections are taken first to the fine grits bolter, V' (Figs. 2 and 7), and thence to the mills, $M^2$ and $M^3$, to be reground. Finally, the rejections from this last bolter are returned to the sifter, Y, in order to pass again to the first converters, R and R'.

When it is required, there are added another pair of reducing rollers, $R^4$, and a flour bolter, $P^4$ (Fig. 7), in order to operate upon such fine grits as there was no room for in the preceding; and the rejections from these are sent to the bolter, Q'.

It is proper to remark that the Messrs. Bell have applied to the mill boxes a system of aeration designed to cool the mills and prevent the escape of mill dust. Fig. 6 shows the arrangement of the piping, and of the blower, W', devised for this purpose.

The stones of these mills are mounted like those in ordinary flour mills. In certain mills porcelain cylinders are substituted for them, but as they have nothing to do but regrind inferior grits, and the hard and cleaned particles of the bran, there seems to be no advantage in making such a substitution. The force employed at the mill under consideration consists only of a foreman, who is paid at the rate of 160 francs per month, and eight workmen, who receive on an average 2·8 francs per day without board or lodging.—*Publication Industrielle.*

## THE WORK ON THE PANAMA CANAL.

### THE COLON SECTION.

In every enterprise the means to be used must be proportioned to the importance of the work to be executed. As regards the Panama Canal, the work being vast, the means have to be of the most powerful character. But, as the Isthmus furnishes scarcely any of the necessary resources, everything has to come from Europe or the United States. It becomes necessary, then, upon a properly chosen spot in proximity to the points of operations, to receive the merchandise of all sorts that is necessary for the work, to land it, to classify it, and, when it is a question of mechanical

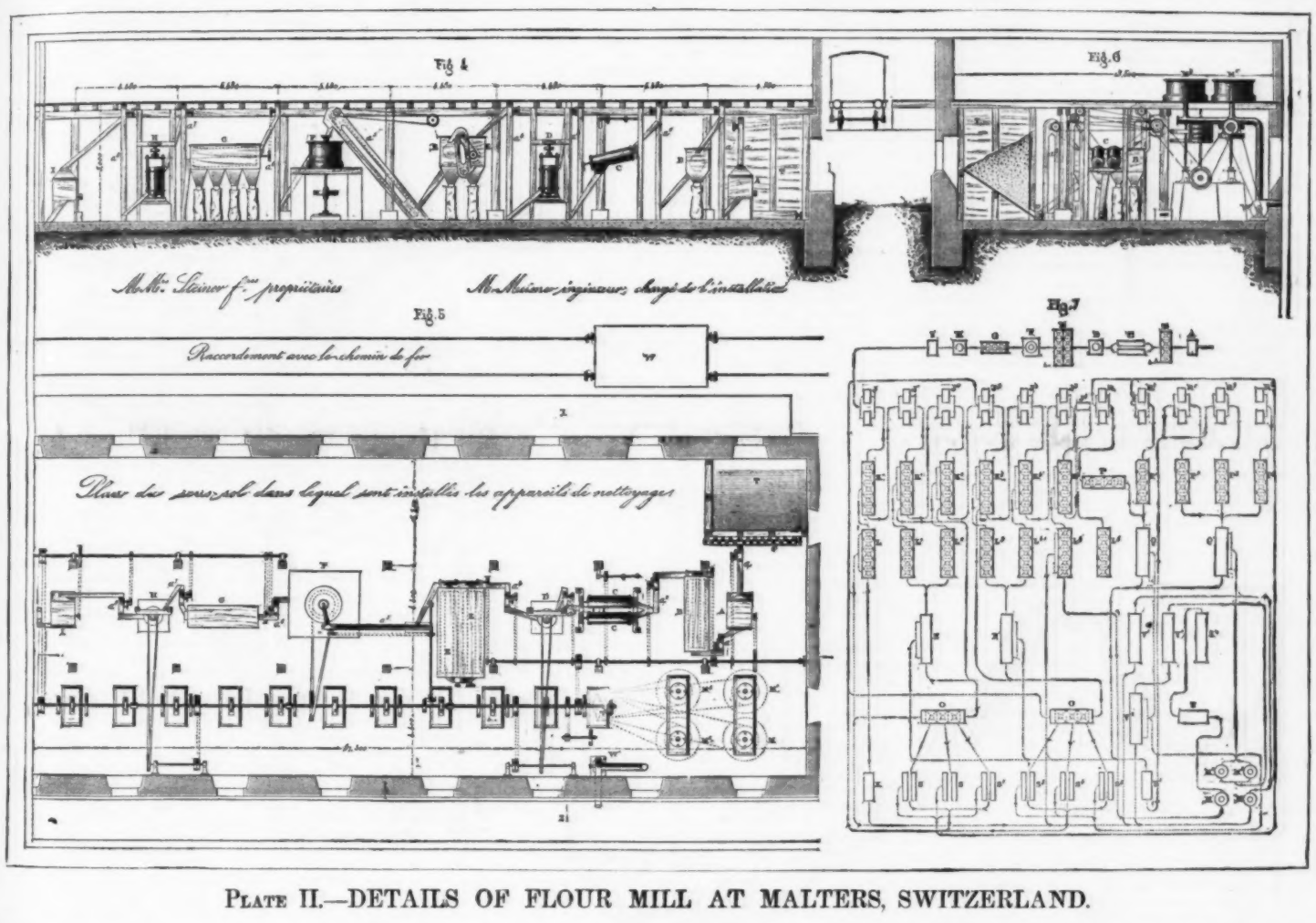


Fig 4
Fig.6
M.M^r. Steiner f^rs. propriétaires
M. Meisner ingénieur, Chargé de l'installation
Fig.5
Fig.7
Raccordement avec le chemin de fer
Plan du sous-sol dans lequel sont installés les appareils de nettoyages

## PLATE II.—DETAILS OF FLOUR MILL AT MALTERS, SWITZERLAND.

machine, there are bagging machines, $f^3$, for bagging the fine bran. This latter is afterward sent to the mill, M, while the coarser bran that escapes from the extremity is sent to another mill, M' (Fig. 5 and 8), the product of which is bolted in the flour and bran bolters, Z and $Z^1$ (Fig. 7).

Such particles of grist as may escape from the end of the bolting machine, K, are, if need be, sent to pair of rollers, $J^6$ (Fig. 7.), which complete the crushing, and from thence to a special bolting machine, L.

*Purification of Cleaning of the Grits.*—The grits that have been separated from the other products have to be exactly classified according to size and perfectly cleaned, and this is why they are passed through sifting machines provided with blowers. The sifting machines employed in the flour mill under consideration are double, that is to say, they are arranged two by two and carry sieves that differ perceptibly from one another in the size of their meshes. Thus, the first has larger apertures than the second, and the latter has larger ones than the third, and so on to the last, which has the finest of all. Besides, the sieve of each machine consists of three parts, that is to say, is combined in such a way as to carry three different numbers throughout its entire length. The first part, upon which falls the material derived from the assorting cylinders, O and O', has smaller openings, so that the particles of flour and grits that are too fine for this machine traverse this part of the seive and fall into an elevator which carries them up to the succeeding sifting machine, whose sieve is finer. The center of the sieve of each sifter has medium-sized aperatures, and consequently the product that traverses it falls into the half, *m*, or the first compartment of the cleaning apparatus properly so-called (Fig. 1). The last part has the largest sized openings in order to allow of the passage of the coarser grits, which are then received in the second half,

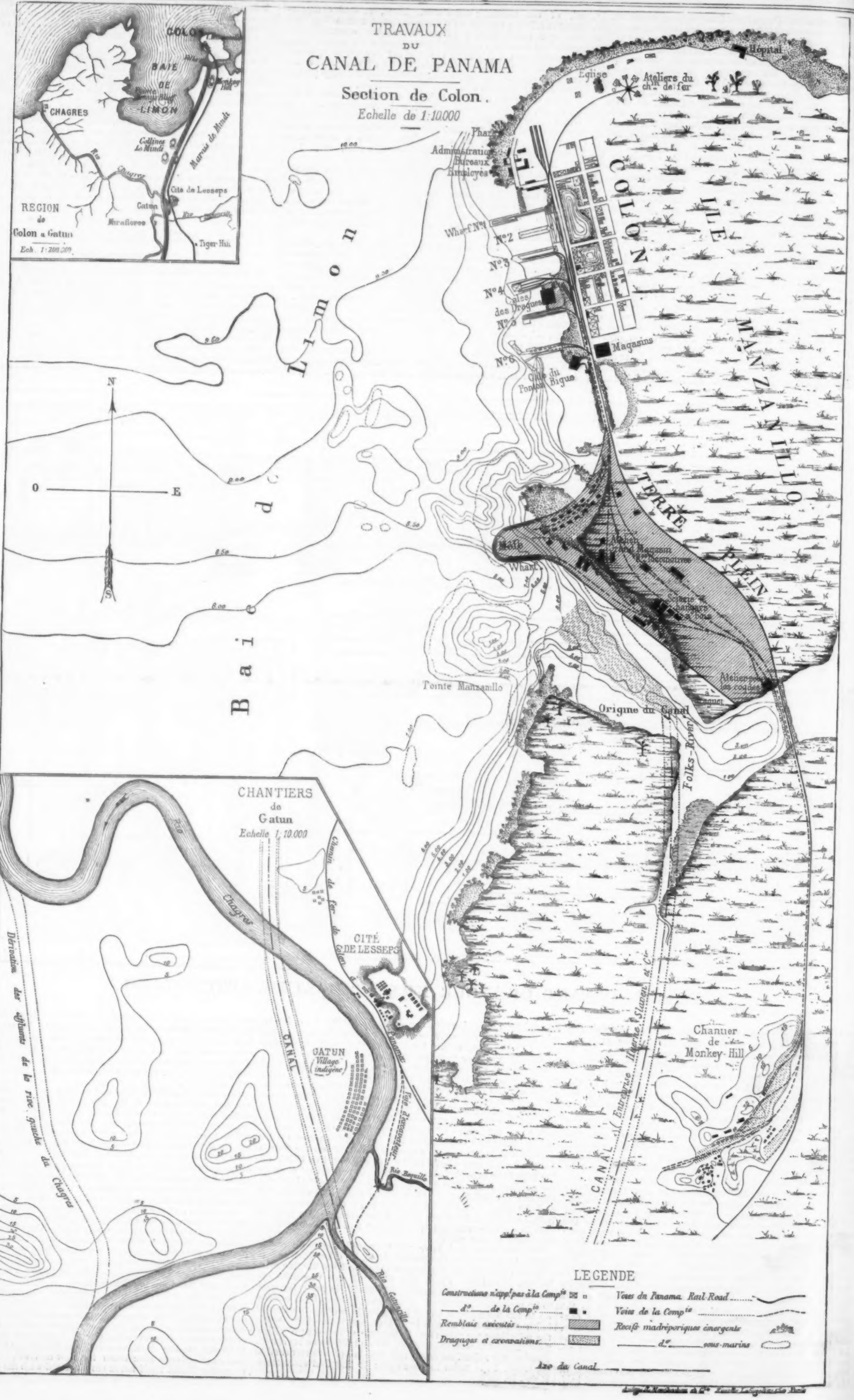
appliances, to effect or complete their mounting before sending them to the sections where they are to be set to work. In a word, it is necessary to have at disposal a port with an entire maritime and industrial equipment, and with docks, storehouses, and workshops. And, after this, it is necessary to have a town for the population that such a center of work calls around it.

It will be readily understood what a capital importance was attached, as regards the Panama Canal, to properly locating and broadly organizing its receiving port, in the very beginning, with its storehouses and workshops.

The place which, at first sight, appeared to be entirely fitted for this purpose was the port of Colon, on the Atlantic Ocean. Colon, in fact, is the port of arrival of several lines of packet-boats coming from Europe and from New York, and is the starting-point of a railroad line that traverses the Isthmus. Moreover, its wharves are in general well equipped for putting the ships and railroad in easy communication.

But, upon a closer examination of the question, the fact had to be recognized that the existing wharves could scarcely be counted upon for the Company's use. These wharves, six in number, belong to different lines of steamships, as follows: No. 1, to the Hamburg line; No. 2, to the Compagnie Générale Transatlantique Française; No. 3, to the English Royal Mail; No. 4, to the Atlas Line; No. 5, to the Panama Railroad; and No. 6, to the Pacific Mail.

Wharf No. 5, having been demolished by storms and the collision of ships with it, was entirely out of service. Ships not belonging to the companies above indicated had, then, no special place to land. As for the steamships, their days of arrival and departure being fixed in advance, cargoes had to be put on the dock as quickly as possible and then removed in order to give room for new arrivals. The Canal Company found itself much embarrassed with the goods that


TRAVAUX
DU
CANAL DE PANAMA
Section de Colon.
Echelle de 1:10000
COLON
BAIE DE LIMON
CHAGRES
Rio Chagres
Gallinas Le Mindi
Marais de Mindi
Cité de Lesseps
Gatun
Miraflores
Tiger Hill
REGION de Colon a Gatun
Ech. 1:200.000
Hôpital
Eglise
Ateliers du ch.ⁿ de fer
Phare
Administration Bureaux Employés
Wharf N°1
N°2
N°3
N°4
N°5
N°6
Cales des Drogues
Cale du Ponton Bigue
Magasins
ILE MANZANILLO
TERRE PLEIN
Malle
Wharf
Ateliers Magasin Forge Menuiserie
Scierie et Hangars aux bois
Ateliers pour les coolies
Pointe Manzanillo
Origine du Canal
Folks-River
Chanier de Monkey-Hill
CANAL (Entrance Harbor Slip) & Cie
Baie de Limon
N
S
O
E
CHANTIERS de Gatun
Echelle 1:10.000
Rio Chagres
Chemin de fer de Colon à Panama
CITÉ DE LESSEPS
CANAL
GATUN (Village indigène)
Tête d'écoulement
Rio Boquilla
Rio Gatunsillo
Dérivation des affluents de la rive gauche du Chagres
LEGENDE
Constructions n'appartenant pas à la Compᵉ
Id. de la Compᵉ
Remblais exécutés
Dragages et excavations
Voies du Panama Rail Road
Voies de la Compᵉ
Recifs madréporiques émergents
Id. sous-marins
Axe du Canal

were thus suddenly thrown on its hands, and for which it had no warehouses. The first idea was to purchase wharf No. 5 from the Panama Railroad Company, and to repair it for the exclusive use of the Canal Company. But, supposing this to be a sufficient solution of the problem in regard to the landing of ships and their cargoes, there remained the question of stores, workshops, and dwellings for the employes. Now, Manzanillo Island, upon which Colon is built, is, properly speaking, only a marsh, in whose interior it is impossible to erect any structures. The west side is occupied at all spots, where it is any way firm, by the city, the railroads, and maritime establishments. The north side presents only quite a narrow strip between the ocean and marsh. It is, however, the pleasantest spot on the island, since the wind is received there directly from the ocean. But space was wanting for large establishments, that were to cover a wide surface; and, moreover, the place would have been too far distant from wharf No. 5, and the roads communicating with the latter would have mixed throughout the whole route with those of the Panama Railroad, whose workshops are at the north of the island. It became necessary, therefore, to renounce all idea of finding any place on Manzanillo Island fitted for the reception of the necessary structures.

We ought to add that Colon has always possessed a reputation for unhealthfulness. Without echoing all the fabulous legends that have been narrated about this unfortunate country, we are obliged to avow that there is nothing pleasant connected with a sojourn in this city. It is, without doubt, the unhealthiest point on the Isthmus, and the chances of falling sick there are further enhanced by the uncleanliness of the colored inhabitants. No attempt has been made to reclaim the marsh except to within a few feet of the houses.

In the face of all these grave inconveniences, Mr. Blanchet, the representative on the Isthmus of Messrs. Couvreux & Hersent, sought another solution of the problem, and that was to form a river port instead of a sea one. At about 9 kilometers from Colon, in following the railroad, and at 14 kilometers from the mouth of the Chagres, is situated the village of Gatun, surrounded by plains that are sufficiently elevated to afford an aspect of salubrity. One of these is situated upon the right bank of the Rio Chagres; and the railroad, running along the river, passes at the foot of it. The canal will run along the left bank, at 200 or 300 meters distance. Between the ocean and Gatun the Chagres is from 7 to 8 meters deep. At its mouth there is a bar, which reduces the depth to about 4 meters. But this is still deep enough for many boats, such as lighters, sail-boats, and tow-boats. Moreover, a dredge could easily have made a deeper channel.

To abandon, then, the unhealthy and obstructed port of Colon and create an independent river port at Gatun, with its basins and workshops on the edge of the Chagres, and its houses upon the plateau, such was the conception of Mr. Blanchet when he gave the order to build "Lesseps City." The work was executed with rapidity, the summit of the hill having been leveled and numerous buildings erected thereon, and the mounting of the first excavating apparatus having even been begun. Unfortunately, the climate proved inimical to the enterprise. The first agents sent to Gatun, not having, as at Colon, any hotels to betake themselves to, had to lodge either in the ranchos of the natives or in unfinished cabins, and thus caught marsh fevers. Some of them having died, and a panic ensuing, Gatun was declared more unhealthy than Colon. The project of a port in the interior was thenceforward condemned. Criticisms came in quantity, and the idea, which had been inspired by a just and humane feeling, was stigmatized as a gross blunder on the part of its author. This first deception was for unfortunate Blanchet the first step toward the tomb.

In abandoning Gatun, where stood the new city sad and deserted, it became necessary to return to Colon. In fact, between these two points it is all swamp; beyond, the Chagres leaves the railroad, and the first point of approach between these two routes lies very distant from the mouth because of the numerous meanderings of the river.

But, although the certain unhealthfulness of Colon was preferred to the perhaps more accidental insalubrity of Gatun, it became none the less necessary to create an entirely independent port, and grounds fitted for the reception of all the requisite establishments. The starting-point of the canal having been fixed in the arm of the sea that separates Manzanillo Island from terra firma, it was decided, from a project conceived and presented by Mr. Hersent, to fill in the marshy shore situated between the railroad and the arm of the sea to the southwest of the island, and to even reclaim a certain extent upon the ocean by running a jetty into Limon Bay in order to protect the future port against high winds as well as waves from between the north and northwest. These fillings-in took the name of "Christopher Columbus Terrace" (*Terre-plein de Christophe Colombe*), and thenceforward the entire activity of this section of the works was turned toward a prompt completion of this indispensable undertaking.

This made land is destined to render great services, and to become the true Port Said of the American isthmus. Gatun, abandoned, on its side, as the principal port of arrival, will, without doubt, with the extension of the works, assume some importance. Its prior bad reputation is gradually being forgotten, while its advantageous situation and the installations that have been made will again be utilized.

It will become necessary, then, to bear in memory the true authors of these creations when some day some new chief of the Company shall imagine that he was the inventor of the Colon *Terre-plein*, and that he discovered the situation of Gatun.

Let us now take up our narrative.

The construction of the terrace (*Terre-plein*) took too long to allow the work of receiving and mounting to wait until it should be utilizable, even in part; so it became necessary to either buy or rent divers small places that were scattered through the inhabitable part of the island. At the northwest point of the latter there was erected a group of structures that included the administrative residence, the offices, a few houses for employes, a shed for the mounting of locomotives, a workshop, and a saw-mill. Between wharves 4 and 5 were installed the inclined planes for mounting the dredges and lighters. Provisional storehouses were located a little to the rear, at the south end of the city, and upon a ground of so little consistency that the buildings became buried during their very construction. Finally, different houses in the city were utilized for offices, small storehouses, etc.

All this naturally proved very inconvenient and occasioned the employes tiresome journeys and a great loss of time. This provisional period of organization will leave in the history of the canal only sad souvenirs. Those who were present will always remember having seen the first chief of the Colon Service working sixteen hours a day, performing all sorts of roles, even that of sick-nurse; and, after having given all his strength, succumbing to the fatigue after three months of superhuman labor. This gentleman was Mr. Antoine Etienne, a well known engineer, and a graduate of the Ecole Centrale, who, before entering the latter, had been a laborer up to the age of nearly thirty-three. It was difficult to find a successor to him; his post remained long unoccupied, but was finally given to an engineer who remained but a short time on the isthmus. A third was removed by fever after a sojourn of two or three months; and, finally, the fourth, whom we can only wish an excellent and long resistance to the climate, has held the reins of this perilous government since August, 1883.

From an administrative point of view, the organization of the department of Colon has undergone some modifications that we must call attention to. In the beginning, Colon formed a sub-department of the work that comprised the works properly so called, the equipage, and the storehouses. Subsequently, it has been thought that this subdepartment was too overburdened, and that, moreover, it was inconvenient to leave in the hands of the chief in charge of the Colon works the direction of the workshops and the storehouses that had to furnish the materials as well as the machines that were necessary to all other sections of the isthmus. Evidently this chief should be placed in a position to look after the requirements of his own points of operations above everything else. So the sub department of Colon was abolished and subdivided into district and independent sections, such as those of works, shops, and *matériel*, and storehouses in general.

Let us now enter upon a description of the work effected in each of these sections: Of the general store we shall have nothing to say except that the Company makes it its endeavor to keep it supplied with all the materials necessary, not only for the work, but for the existence of its employes. It is amply provided with food products, furniture, bedding, and linen, which are furnished to the employes at prices such as to place them in good circumstances when they chance to quit the works. Mr. De Lesseps was opposed, in principle, to an organization which, it is true, offers a disastrous competition with local trade; but, practically he tolerates it, since the employes have above all things the right to obtain objects of prime necessity easily and cheaply. Mr. De Lesseps's opinion was inspired by a broad idea of equality and liberty; but, taking all things into consideration, it is preferable to listen to a few recriminations from cosmopolitan tradesmen than to the just complaints of men who are working and exposing themselves daily, and who have at least the right to require the Company to provide them with a material existence free from too great a care.

The statement of receipts and expenditures of the general store figures up each year several millions of francs. The section of shops and working-stock has received from the United States or from Europe all its large apparatus, and this it has had to mount before distributing it among the different working points along the line of the canal. A few figures will show the importance of the work that devolves upon this section of the service: Out of 60 locomotives ordered in Europe, 27 have been shipped to the isthmus, and 20 of them had been mounted and delivered to the sections at the beginning of 1883. Dirt cars of 3, 4, and 6½ cubic meters, platform cars, baggage cars, etc., have been ordered to the number of 2,000, and about 600 of them have been sent out, and most of them are in use. These cars are mounted partly at Colon and partly at Gatun, which latter is tending to become, as we have stated, a center of work. More than 50 endless-chain excavators, of the Couvreux or analogous systems, have been ordered, and 18 have been shipped, and mounted as fast as they arrived. Evidently there has been a delay in the shipment of these apparatus; but it must be taken into consideration that in order to set them at work there must have been executed upon the ground some preparatory work, which takes so much the longer in proportion as the land is more broken. Several American excavators have been asked for by some of the contractors, and a few of them have reached the isthmus and been mounted. The dredging plant comprises 4 dredges of an effective 60-horse power, which are now in service, and the complete mounting of which, including the riveting of the hulls, was performed at Colon. Punts, lighters, barges, etc., 64 in number, have been sent from Europe, and have all been or are being mounted at the section of workshops, with the exception of two large steam barges, which, built in Scotland, crossed the Atlantic of themselves. These last-named vessels measure 41·9 meters in length by 7·62 meters in breadth amidship, and were each loaded during their voyage with two steam yawls. Mr. Lobnitz, the builder of these boats, sent also a marine dredge designed for the works at the port of Colon. This dredge started from Gaveloch, Scotland, on the 10th of last April and reached Colon on the 16th of May. Its principal dimensions are: length, 51·8 meters; breadth, 7·9 meters; depth, 3·65 meters. The two engines, one of which actuates the bucket-chain and the other the screw propeller, are of 250 H. P. It took about fifteen or twenty days to get this apparatus at work after its arrival at Colon, since it had been thought proper to remove the chain and buckets and close up the well-hole for the latter, and to make a few other arrangements for so long and so perilous a journey. Mr. Lobnitz is to build another and similar marine dredge, which is to go to Panama. We wish a safe voyage to the brave seamen who are to cross the Strait of Magellan, or double Cape Horn, on this new kind of steamer.

To return to the working stock that more particularly concerns the section of workshops, we may mention also the floating landings, one of which is in service and the other almost mounted. The riveting of the hulls was done at Colon. The naval equipage is completed by a flotilla of steamboats, exploring yawls, and tow-boats of from 50 to 150 H. P. Two of these latter traversed the Atlantic of themselves, while all the others had to be mounted in place, with the exception, however, of the small yawl-boats, which were transported entire. For the workshops and various points of operations there were sent to the Isthmus 34 portable and half-stationary engines, varying from 4 to 35 H. P., and all from the works of Messrs. Weyher & Richmond.

Finally, among the hoisting apparatus, we may cite the following: One 5-ton crane, mounted upon an iron pontoon, and about fifteen 2 to 6-ton ones that are either stationary or fixed upon cars. We leave out of view all the apparatus of less importance, such as lowries, trolleys, pumps, reservoirs, windlasses, etc., which, although they do not take so long to mount as do the preceding apparatus, yet cause, on account of their great number, considerable work. It will be seen from this simple enumeration how important the mission of the workshops is, and how proper it is to have constant care that this service shall be in possession of the means of performing its task with rapidity and economy. With the advance of the work of excavation the repair of the stock is going to be added to the labor of mounting.

Up to the present time Colon has but one small repair shop, and that is of the type known as the "section shop." The equipment of this will soon become insufficient. The Company had determined on the construction of a large shop for mounting and repairs, which was at first designed for Colon; but, on the one hand, the healthfulness of this city is not always reassuring, and, on the other, the works that will employ the most apparatus will be situated toward the middle of the Isthmus.

It was therefore decided to have three principal workshops instead of one only, the first of which will be located at Colon, the second, and doubtless the most important, at Gorgona, near the center of the Isthmus, and the third on the Pacific slope. In this way, carriages to a great distance will be avoided, and, in case an epidemic should happen to render a momentary vacating of one of the shops necessary, the work will still have two others at its disposal. We now arrive at the section of works, properly so called. Efforts in this section must be directed toward three principal objects:

1. The construction of the "Christopher Columbus *Terre-plein*."
2. The excavation of the port of entry of the canal.
3. The opening of the canal itself, from its beginning up to a point that will be fixed at Gatun (9 kilometers) or beyond. The following section has begun operations at Buhio Soldado, at the 20th kilometer. The limit of the two sections will be fixed eventually between this latter point and Gatun.

*The Terrace.*—The formation of the *Terre-plein*, or terrace, will require about 350,000 cubic meters of filling. It would certainly have proved advantageous to apply to this the material excavated from the canal or port; but, in all the adjacent portions of Colon, this material consists of mud, or of living madrepores whose influence upon the health of the employes was to be feared were it exposed to the sun over the wide area that was destined to receive the dwellings and work-shops. Moreover, the material derived from dredging was less in quantity than that which was to be taken from the dry excavations. It was decided, then, to take out, in the vicinity of the terrace, earth that should be sufficiently dry and compact, although easy to excavate, and for this purpose the small hills of Minzi were selected, these being near the line of the railroad, at 1,200 meters from Manzanillo Island. These hills, which rise to about 15 meters about the sea-level, are composed of a compact clay derived from a decomposed tufa.

The first excavators that were mounted were set in operation at the fact of the hills and worked from beneath.

At the beginning of 1883, the Monkey Hill works were employing two Couvreux excavators and two American ones, besides several gangs of men working with picks. All the apparatus, however, did not always work simultaneously. The American excavators, among others, have not shown what they can do during a continuous and regular work.

But it did not suffice to merely remove a certain amount of good material, for it was also necessary to carry it to its destination. Now, to borrow for such a purpose the railroad from Colon to Panama was to put the work at the mercy of a company which would always be finding some obstacle to put in the way of the trains loaded with earth. So, in the month of June, 1882, it was decided to establish a second road along the one that already existed.

Thanks to this special line, it has been possible to carry on the work at Monkey Hill with all the despatch desirable; and the number of cubic meters removed each month from the beginning of 1883 and carried to the terrace has been from 15,000 to 20,000.

The external contour of the *Terre-plein*, or terrace, exposed to the ocean waves necessarily had to be protected by rockwork. To procure the necessary stone, which Monkey Hill could not supply, it became necessary to open a quarry upon the west bank of Limon Bay, at Kenny's Bluff. The carriage was effected by lighters and tow-boats.

The opening of these works led to the discovery of a spring of potable water, which was a fortunate find, since Colon was absolutely destitute of it. The exploitation of these quarries remained for some time in the hands of Americans, but it became necessary to cancel the contract, as the contractors did not fulfill their engagements. The same trial, moreover, was made at Monkey Hill with no better results. It is to be hoped that the Canal Company, after being taught by a succession of small mistakes, will eventually recognize the fact that it is better to rely upon the concurrence of its European employes, who are usually capable agents, than upon that of foreigners picked up on the spot, whose aptitude, readiness, and antecedents are unknown.

Kenny's Bluff, under the direction of the Company, is sending monthly to the terrace 1,200 cubic meters of large blocks of stone. This is not much, but we must take into consideration the difficulties attending loading and carriage. The American enterprise did not reach half this figure.

Having seen whence are derived the materials necessary for the terrace, we shall now describe this latter work, which is so important for the canal works, and also for its future exploitation.

The filling in is nearly completed, and covers a superficies of 30 hectares that has been reclaimed from a very low, marshy soil, and from the sea by ground running out as far as 8 meters. At its northwest extremity this made ground is prolonged to a length of 200 meters, with a mean width of 115 meters, so as to form a vast jetty. The line of quays protected by the latter is 900 meters in length, or, rather, it will reach such a length as soon as the necessary dredgings are completed along the entire length so as to allow ships to approach. At present there is arranged on the inside of the jetty a wharf which rests upon wooden piles, and which is 135 meters in length and 12·5 in width. This has just been entirely covered, so as to protect goods when unloaded upon it.

Fig. 1 gives a transverse section of the wharf and jetty. The construction of the wharf required the driving of 270 piles that form 54 transverse rows of 5 each. The piles in each row are 3 meters apart, and the distance between each row is 215 meters. Thepiles are driven down as far as they will go, 8 to 9 meters, into a bank of coral, and are shod and protected with thin sheet copper in order to secure them against the attacks of the teredo. The structure, then, is solidly built in view of a long use

The entire surface of the terrace is designed to receive the Company's buildings. The tracks which are now laid upon it are such as were used during the period of construction, and serve at present to connect the different storehouses, sawmills, shops, etc., with the Panama Railroad.

These tracks will doubtless be relaid hereafter according

to the requirements of the new installations to be made. It should, in fact, be understood that everything has not been placed in a definite position according to a plan ordered in advance.

In Fig. 2 will be observed how well are arranged the employes' dwellings, which are built along the curved portion of the terrace and facing the open sea. These houses, which are in two rows, but which do not prevent the access of the sea air to each other, form a street that has been called Charles de Lesseps Street, in honor of the voyage that the son of the president of the Company has just made to the Isthmus. The houses in this street are of three types, for 1, 2, or 4 employes. The smallest comprise two rooms, a kitchen, and a veranda; the whole being upon one floor

FIG. 1.—SECTION THROUGH THE JETTY AND THE CENTER OF THE WHARF.

slightly elevated above the ground. The second type, which is the one shown in plan view in Fig. 2, is, so to speak, formed of two houses of the preceding type placed side by side. The third type is No. 2 with a story added. This similarity is very convenient and permits of distributing the houses by two, four or eight rooms according to the grade or the family of the employes.

We may add that wharf No. 5, which was bought and repaired, has been connected by a special track with the made land, of which it forms an important annex.

*Dredging of the Port.*—The immediate object of dredging the port is to permit of the landing of ships along the terrace, and to form a pass for bringing in the apparatus which is to do the excavating—this excavating being the object of a particular enterprise of which we shall presently speak.

The dredgings under way have been retarded by the fact that the sea is often quite rough in the portion to be made deeper, and that, before the construction of the jetty, the apparatus that had been set at work could not be put into a place of shelter in case of bad weather.

The marine dredge, of which we have spoken, will for these reasons render great services, since its dimensions, its marine form, and especially the facility with which it moves

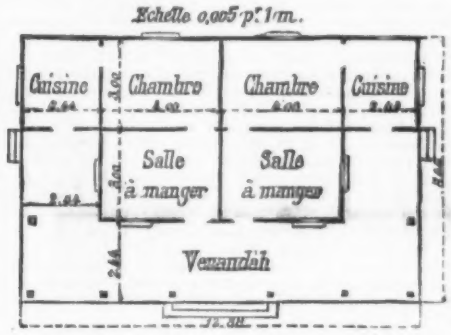



FIG. 2.—PLAN OF A HOUSE FOR TWO EMPLOYES.

of itself with its helix will permit it to withstand a rough sea and to take refuge all alone if the latter becomes too tempestuous. Meanwhile, in its absence, and profiting by calm weather as well as by the shelter offered by the jetty in measure as it advanced, the dredges mounted at Colon have been utilized. Two of these have worked quite regularly, and each has dredged up from 800 to 1,000 cubic meters per day. This is a very satisfactory result when we consider that the carriage of the material could only be done by much too small a number of punts, and that banks of madrepores have several times stopped or retarded the work. When one of these banks is met with, dynamite cartridges are sunk, and the explosion of these sufficiently disintegrates the mass to allow the dredge to raise more or less of it. If the reef has not been broken up to the required depth, the operation is performed over again. It will be seen, however, that this work, which is apparently simple, causes the dredging machines to lose much time.

As regards the part that runs along the line of the quay, mine holes were bored into the bottom in order to obtain a greater effect and to break up the earth in a more regular manner. It is important here not to disintegrate the ground that supports the filling.

Our plan shows the zone that had been dredged up to the end of last February, the depth obtained being 5 meters. At this epoch a free communication had already been effected, then, between the sea and the point of the canal properly so called.

The dredges are now going to deepen that part of the Folks River which is located opposite the railroad jetty. There will be an excellent refuge here for all the naval apparatus, and inclined planes for repairs are being established at the corresponding extremity of the terrace.

The dredges under consideration empty their material into barges to the right or left by means of lateral spouts; but they may be easily converted into long-chute dredges by attaching to one side of them a boat carrying shears for supporting the chute (which may be 50 meters in length), and to the other a pump boat containing the machinery designed located in the marshy part, situated between the Mindi Hills and the mouth of the Folks River on the one hand, and between the railroad and Limon Bay on the other. There will be no lack of excavated material for forming embankments on the neighboring land.

*Digging the Canal.*—At the point where the Company's dredges leave off, begins the canal properly so called. From this point as far as to Gatun, the work has been given out under contract to Messrs. Huerne, Slaven & Co., of San Francisco. The principal clauses of the contract are as follows:

The contractors must provide their own tools and apparatus, begin work in the month of August, 1882, and be under full way three months afterward, that is to say, must take out, beginning with the month of December, 9,000 cubic meters per day. The digging of the canal must be done in three successive passes, the first having a width of 25 meters at the level of the water, and a depth of 2·5 meters, in order to secure a quick communication between Colon and Gatun; the second having a depth of 4·5 meters; and the third reaching the complete width and depth of the canal, or 50 meters at the water level by 8·5 meters (Fig. 3). These three passes are to be completed, the first, one year after the day fixed for the beginning of the work, and the two others, two and a half years after this same day.

The price per cubic meter dredged up to 6,000,000 cubic meters is fixed at 1 franc and 50 centimes. This price will be reduced to 1 franc 25 centimes for the quantity that shall exceed the 6,000,000.

In case the ground shall require the use of powder, special contracts will be made for its excavation.

In order to judge of the manner in which Huerne, Slaven & Co. will execute the work that has been allotted to them, we shall have to wait to see them at work. But we are obliged to confess just at present that they are not attaching a great value to certain articles of their contract. In fact, their first dredge, which should have been in operation in the month of August, 1882, reached Colon only in April, 1883. Of the period of greatest activity which should have begun in December last, with 3 dredges, excavating 9,000 cubic meters per day, there is as yet no evidence at the present moment. Will the engagements entered into regarding the completion of each of the passes be kept any better? It is surely allowable to doubt it, since the time for the first expires in the month of August, next. Finally, American journals have given us certain dimensions of these dredges, which latter do not appear to be well adapted to the work to be done. The Huerne dredges, which are endless chain ones, like those known in France, are 30·5 meters in length, 18·25 meters in width, and 3·65 in depth. They are obliged to excavate a canal in *terra firma*, and consequently to open a way sufficiently wide to allow them to move about in it without the angles of the hull alternately touching one bank and the other.

Now, the first trench to be opened, which must be 25 meters in width at the water level, will be only 17 at the bottom, that is to say, 1·25 meters less than the dredge. Even were this difference in width *nil*, the dredge would, so to speak, be set into the trench without in anywise having the power to make the necessary movements for ditching in advance of it. It would then be inconsiderate to ask Messrs. Huerne, Slaven & Co. how they expect to perform the work specified in the contract and so useful to the Company. It is true that the contractors, in having machines built that at once excavate the canal to its entire width, free themselves from the subjection of working in a trench in which the moving of the Company's apparatus would prove an annoyance to them.

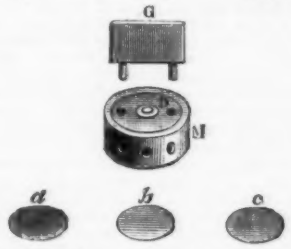
To end with the Colon section, let us now transport ourselves over to Gatun, where we shall see that one of the Company's dredges, which arrived by way of the Chagres in April, 1883, is making a cutting that is designed to turn aside the water from the river to the west of the native village and the canal. In this way there will no longer be any fear of an overflow into the canal cutting; and, later, when the waters of the Chagres itself shall have been carried over to the other bank, that is to say, on the same side with the railroad, the passage that has been cut will serve for the flow of the waters derived from the affluents of the left bank.—*Le Génie Civil.*

DR. LADELL has discovered that prussic acid is an antidote to poisoning with strychnine. Medical men will be cautious in using it, however, as the prussic acid, to be of any use, must be given in doses which would be fatal under any other circumstances.

## SOARES' MINIATURE MEDICAL PILE.

MR. SOARES has brought from Lisbon a very minute pile, which is much in use on the other side of the Alps, and which is designed for the cure of neuralgic pains in the gums. The apparatus, which is shown of actual size in the accompanying cut, consists of a small ivory box, M, in which are superposed fifteen small disks, *a*, *b*, *c*, of copper, paper, and zinc, forming five small Volta couples. By means of a compass key, G, there are screwed to this box two small silvered copper disks, D. The disk that communicates with the last zinc circle carries a mark. This is the pole that must be placed against the gum, the positive one then pressing against the lower part of the lip.

To actuate the pile it is plunged for a minute into a strong solution of salt in water. It is then dried, and is ready to operate. The water enters through the apertures, *r*. In spite of its small size, this pile is quite intense, and it is not well to apply it for more than five minutes, since, after this time, a decomposition of the tissues occurs, this being shown by a small white spot at the negative pole. If, at the end of such a period, the pain has not disappeared, it is probable that the remedy will not act longer. If the positive pole be

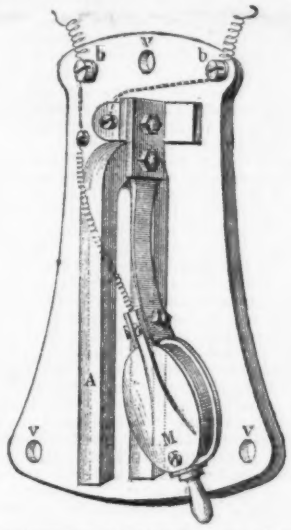



applied to the affected part, the pain instead of disappearing will increase.

The pile is capable of serving quite a number of times, it being only necessary to renew the paper disks, a certain number of which are furnished with the apparatus.—*La Lumiere Electrique.*

## SUPPRESSION OF PILES IN ELECTRIC BELLS.

DESPITE the attempts made to do away with the use of piles in electric bells, the French have not as yet come to use any special apparatus for the purpose, although in other countries what is known as the "magneto cell" is frequently employed. This latter consists of a peculiar arrangement of the electric machine, set in action by a winch.




It will be readily conceived how much interest attaches, in the working of a telephone line, for example, to the substitution of a mechanical apparatus, attended with no expense, for the present system of bells employing piles.

Apropos of this, we believe it of interest to call attention to an ingenious and very recent invention of Mr. Abdank Abdakanowitcz, the figure of which, herewith given, will serve to show its happy combinations.

The apparatus consists of a permanent horse shoe magnet, A, fixed vertically and placed upon a support to which it is fastened by means of screws at V, V, V. Between the branches of this magnet there oscillates a small flat bobbin, M, which has great resistance and which is suspended from a spring and placed, at the terminals, *b*, in the circuit of the bell that is to be actuated. In deviating this piece from the vertical, and then suddenly leaving it to the action of the

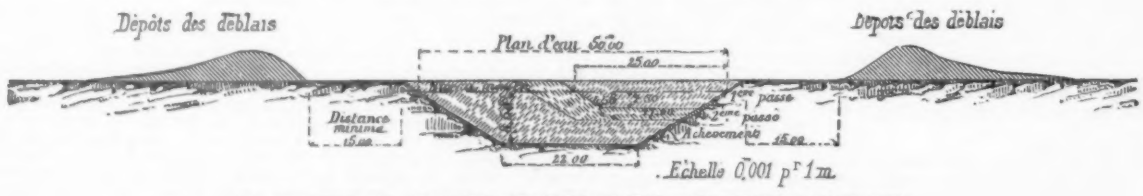



FIG. 3.—TYPICAL PROFILE OF THE CANAL. (HUERNE CONTRACT.)

spring, a series of oscillations of the bobbin is produced, and there are then formed induced currents capable of acquiring considerable force and overcoming a great resistance. As may be seen, the apparatus is very simple. It requires no keeping in repair, and it is as easily set in action as are the bells now used employing piles.—*Revue Industrielle.*

## THE ELECTRIC LIGHT AT MOSCOW.

IN our time, great popular fêtes can no longer dispense with the wonderful luminous effects that can be obtained by means of the electric light; and so, when last summer the Czar of Russia finally decided to have himself crowned with solemn ceremony, the city of Moscow prepared for the eve of the event a series of luminous decorations that left a deep impression upon the gigantic crowd which had come in from all parts of the empire, and upon the innumerable visitors that had been attracted thither from various points of the old and new world.

The reception of the deputies from the Cossack and Asiatic part of the population occurred on the 28th of May, at the Kremlin Palace. This part of the programme was particularly curious because of the strangeness of the costumes and types that were represented in the delegations which had been sent from the most distant points of the territory.

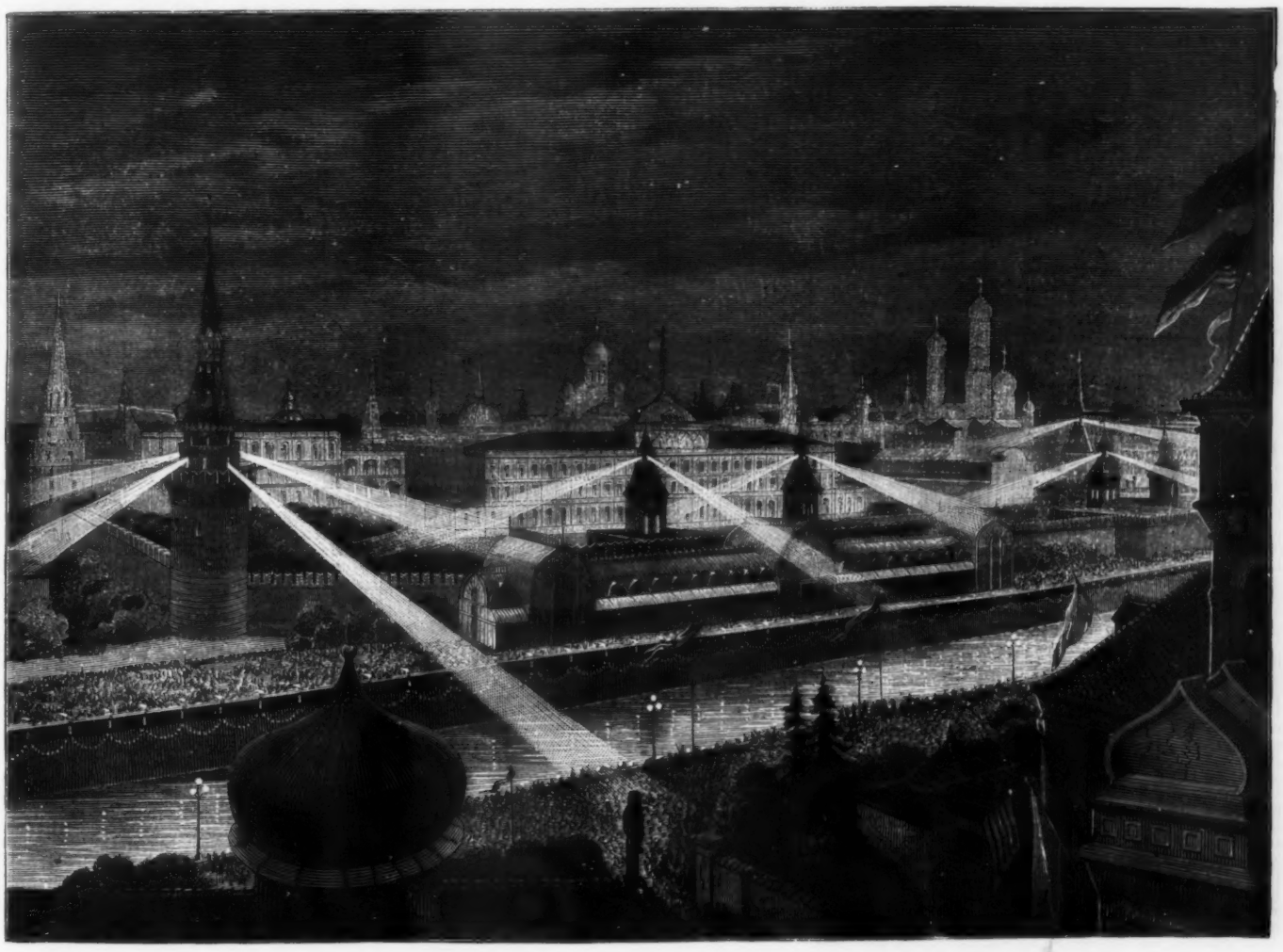
The Hall of the Throne had been arranged for the ceremony. Towards one end of it rose the imperial throne, and, on the left, were placed the imperial insignia and the flag of the empire. Grenadiers of the *Compagnie Dorée* formed the guard of honor, and the Czar and Empress stood in front of the steps of the sumptuously decorated throne. In measure as each delegation presented itself, its chief offered the gold and silver plate containing bread and salt, which was afterward placed upon a table alongside of the windows overlooking the Moskowa.

The promenade of the court at the Kremlin, which was brilliantly illuminated at night by the electric light, took place in St. George's Hall. The cortége was preceded by the masters of ceremonies clad in green tunics decorated with embroidery, and carrying in their hands a golden baton, two meters in height, surmounted by the double-headed eagle. The orchestra at this moment played the Glenka Polonaise, and, at the sound of this, the imperial cortége, guided by the Emperor, executed the *Kourka*—a traditional promenade through a crowd bowing with respect.

Outside, the true popular fête was much more picturesque. It took place in the plain of Kodinskoie-Pole, about two kilometers from Twerskaia, opposite the Petrowski Castle. This plain, which has a superficies of nearly five square versts, had been surrounded by a barrier of small barracks, presenting 400 entrances. Each person on passing through the wickets received a small osier basket containing cakes, a pound of bonbons, a bottle of liquor, and an earthen goblet. It is estimated that 428,000 persons entered this vast inclosure and received the popular present.

In the center there was a circus capable of holding fifteen thousand persons, this being flanked by four theaters in which were exhibited the drama, pantomime, and military pieces. After these day exhibitions, came a night fête, whose brilliancy was such that no idea could be given of it by any known comparison. For some time past, electric arrangements had been under preparation, and, by successive trials, all the apparatus had been ascertained to work well. Never, until then, had there been lighted within the same space a like number of lamps. Trimmings formed of Edison lamps were mounted on the high tower of Ivan Velikoi, which rises in the center of the Kremlin, and formed silhouettes of fire of most fantastic forms; and, at the same time, the belfries of the strange cathedral of Wasili-Blajenoi were illuminated with many-colored facettes, while a scintillation of electric points, running along the pinnacles of the ancient citadel, and reflected by thousands in the bed of the Moskowa, seemed to give the waters of this usually dark river the appearance of a vast sheet of molten metal. Upon the eighteen towers of the Kremlin there had been arranged, in addition, enormous regulators, which shot their luminous fascicles to a far distance, and illuminated the cupolas of the Terem, of the Temple of the Saviour, and of the cathedrals of the sacred precinct, as if with a continuous lightning flash.

It is this last part of the electric illumination that is represented in our engraving, which shows the immense fascicles of light emerging from all parts of the towers of the Kremlin and projected against the surrounding structures, and which gives an idea of the wonderful way in which the electric light contributed to add to the fantastic side of the fête.—*La Lumière Electrique.*



THE ELECTRIC LIGHT AT THE CORONATION, MOSCOW.

## THE TRINIDAD COAL MINES.

ISAAC T. GOODNOW.

WE were now coming east, on a beautiful afternoon, just in the right mood for enjoying the scenery. The railroad very nearly follows the old Santa Fe trail, and also the present well traveled wagon-road over the Raton Mountains, whose fantastic peaks tower right and left to the skies, with openings occasionally to the north that enable us to see, low down in the horizon, the famous Spanish Peaks, one hundred miles away, a wonderful demonstration of the purity of the atmosphere. Just before leaving New Mexico, the train suddenly plunges into a tunnel 2100 feet under the highest crest of the Raton Pass, and on emerging we find ourselves inhaling the pure air and enjoying the bright, mellow sunshine of a Colorado day. The highest point of the Raton Pass is 7861 feet, and of the tunnel 7688 feet, a height of 173 feet saved by the tunnel. On leaving this we pass the Devil's Canon, and in five miles reach the foot of the pass at the little station of Morley; farther on four miles we find Starkville, a sort of suburb to Trinidad, and the site of a remarkable coal mine, stopping an hour and a half to examine it.

The veins of coal are horizontal, and from nine to fourteen feet thick; no finer bituminous coal can be found. This mine has been worked steadily one and a half years, and yields three hundred tons a day, and ninety tons of coke. This is made by heating the coal in ovens to a red heat, and driving off the water and gases. One hundred pounds of coal will make fifty-five pounds of coke, which is nearly pure carbon. Forty-two ovens are in operation here; one hundred and fifty-five men are employed, nine hours constituting a day's work. Laborers outside are paid $2 per day; inside, $3; for mining coal, sixty cents per ton is paid. The laborers are Americans, Swedes, Italians, and Mexicans. We entered the mine on the east side of the mountain by a tunnel six to eight feet wide, and perhaps twelve feet wide, coal above, below, and on both sides, glistening from our little lamps like black diamonds, and generally constituting a self-supporting roof. We penetrated in a straight chute 1400 feet, finding openings to the right and left, with occasional doors to regulate the draught of air which is supplied by fans on the outside driven by steam-power. Turning to the left some fifty feet, we found what appeared to be a small engine with a horizontal cylinder, made so as to drag along the ground, and working a drill horizontally. The machine is really operated by compressed air forced into the mine through iron pipes, which are connected with the machine by flexible rubber tubes. This machine is placed at the end of the tunnel and is moved by hand from one side to the other at the bottom, and by its effective action cuts to pieces a thin layer of coal under the great mass at the end of the tunnel; two holes, twelve feet apart, near the top of the mine, are bored and cartridges inserted, and the mass of coal at the end of the passage way is blown off, several tons at a blast; quite an improvement on the old pick. Everything is systematized and moves like clock-work.

Friday, May 18th, 4 o'clock, P.M., finds us at Trinidad, the guests of its enterprising and hospitable citizens. With an elegant array of carriages we were met at the depot and driven over the city, and those who wished went to the Engle coal mine, three and a half miles away. At the mouth of the mine, at the west and south, we found a comfortable little mining town of some five hundred inhabitants, representing the usual nationalities. The coal beds, three in number, usually crop out near ravines, are easy of access, and are naturally drained. The beds are horizontal, no shafting or hoisting is necessary, there is no dampness or bad air, as in most mines. These veins are parallel, varying in thickness from six to fourteen feet. The middle one is worked the most; the roof of this is light-colored sandstone, and sufficiently strong to sustain itself, consequently saving all expense in blocking. Never before have I seen such a rare combination of circumstances to produce first-class coal with so little labor, so little inconvenience to health and life to work the same. We notice here the mouths of two other tunnels, one opening into a mountain on the north and the other into a mountain on the east, both the mountains joined together at the base. The north tunnel runs clear through the mountain and also connects with the east tunnel. The magnitude of the work may be realized when it is understood that there are twenty-six miles of underground railway in this mine.

Two hundred and seventy men and boys are here employed, and the amount of coal produced each day is one thousand tons; its cost of production is sixty-two and a half cents per ton; this includes interest on investment, wear and tear of machinery, weighers' and superintendent's salary. Coal sells at the mine at one dollar and a half per ton, leaving eighty-seven and a half cents profit. On one thousand tons, the product of this mine per day, yields $875, or $319,875 per year, a very fair profit. Coke sells here at $5 per ton, though formerly brought from Pittsburg at $25 per ton. To produce coke costs $2 per ton, leaving a profit of $3 per ton; two hundred and fifty ovens will produce three hundred and twelve and a half tons each day, or a net profit of $93,740 per year. After a general survey of the outside, some twenty of us, with the Hon. E. J. Morrill, M. C., than whom a better traveling companion never existed, with lamps in hands, took our seats in some half dozen coal cars, drawn by three fine looking mules. At the crack of the whip, we plunged into the earth, every face glowing with expectation and excitement. The similarity of the Starkville mine renders a description of this unnecessary; they both belong to the same great system of coal measures underlying this portion of the Raton Mountains and comprising an area of one thousand square miles. How far we penetrated I can only guess, probably three-quarters of a

mile; here we left the cars, and walking a short distance, found a new machine, operated by the same motive power as the machine described in the Starkville mine; this has been used about two years and is an improvement upon that.

This machine, instead of having the drill of the other machine, has an iron roller four feet long and two and one-half inches in diameter, armed with projecting teeth. This, when pressed against the bottom of the coal at the end of the tunnel, by revolving rapidly cuts away the foundation of the great body to the thickness of the rollers, two and a half inches, four feet wide, and projecting under the coal some five feet; when one breadth is cut, the machine is moved one side to another cutting, till the whole mass of coal at the end of the tunnel, some twenty feet across and five feet in width, is undermined. Two holes two and a half inches in diameter and twelve feet apart near the top of the mine are then bored six feet in depth, and a pound cartridge inserted in each. The joint explosion throws off some twenty tons of coal. Only two of these are used in the mine. The old pick still plays an important part. A shout of "all aboard," and we are speedily in our little cars, and Jehu with a flourish of his whip sets our faithful animals upon a jump till we find ourselves again upon the outside of the earth.—*Kansas City Review.*

## THE NORTHERN PACIFIC RAILROAD.

IN order to form even a moderately appreciative idea of what importance should be attached to the completion of this great work, it is nearly indispensable to have lived in the midst of the seclusion common to the entire region of California and Oregon, when our only means of communication with the outer world on this side of the continent and in Europe was, first, by steamer, once a month, and later still, twice a month, then by overland stage (which was in itself a great advance), and then, finally, by pony express. The feverish anxiety which would send half a community tumbling out of their beds to rush to the window or the door when the newsboy's cry, "New York papers," broke the silence of the night, only showed the state of expectancy in which we lived, and the intense need we felt continuously for some line or chain which could link us with "home."

This may be called the sentimental side, but the practical business side showed itself when a merchant could well afford to pay fifty or even a hundred dollars for a single copy of a newspaper, provided he could get it an hour or half an hour before any other copy came to hand. It was not possible to live or do business in such a state of things without a constant strain and a constant danger, individually and as a community. And when therefore we heard in San Francisco the roar of bells and of cannon, which rang out for us as they did in the Eastern cities as well at the moment that Gov. Stanford's hammer completed the circuit by coming down on the last spike in that dreary desert land north of the Great Salt Lake, the spike that made the Central Pacific and the Union Pacific one contiuous line for travel trom the Pacific to the Atlantic network of roads, our hearts fairly bounded and venerable patriarchs acted like so many school boys. We felt that a new life had come, and it is but reasonable to say that the result, since the opening of that first line, has shown that we did not overestimate the value of the achievement.

This first road was naturally but the forerunner of others; of how many others it is not for us as yet to even guess. And inasmuch as the difference between nothing and one is, so to speak, infinitely greater than between one and two, or one and three, it might be readily inferred that the opening of the second—the Southern Pacific with its connections and dependencies—would awake but little enthusiasm; yet now that we have reached the completion of the third—the Northern Pacific—it really seems as though we were brought face to face with an event scarely inferior in its results to the great predecessor of all, the Central and Union.

The reasons which lead us to this belief are well worth considering, and before looking to see what really has been accomplished by the company, under the management mainly of Mr. Billings and Mr. Villard, in the completion of their line or lines, from Lake Superior to the Pacific waters, we will note one or two features which distinguish this new road from the two preceding lines.

The first point to be made is that which cannot fail to strike even the least observant traveler, as he carelessly sits and glances out of the windows on his passage across the continent. It is the nature of the country through which he passes.

We will start with him from San Francisco by the Central Pacific road. All the country for about 120 miles is charming, and is productive to a degree that is delightful. By this time he has entered the foot hills of the Sierra Nevada, and is leaving behind him not only the evidences, but also the possibilities of agricultural development. The hills are becoming barren, and though the intervening valleys are tolerably fertile, they grow less and less extensive, and when he has reached, say New England Mills, fifty miles this side of Sacramento, he has passed the last land of productive value which will greet his eyes for many a long, and perhaps he will call it tedious stretch. He climbs up the long slope of the Sierra Nevada, magnificent in its scenery, but yielding small profit except in an æsthetic way. A little lumber from the sugar pines (*Pinus Lambertiana*) may be reckoned, and as he rattles down the short eastern slope more lumber occurs, but nothing beyond what a few mills at Boca, etc., can utilize, and just below Verdi he opens into the valley which skirts the eastern base of the mountains. Alkaline sand, clothed with gray, withered looking sage brush, is what he sees down past Reno, and on through the cañon until, at the Big Bend of the Truckee, he opens on the desert, and then, in the vernacular of the country, "Good bye, John!" The stamp of "the desert's death" is all about him. For sixty miles his engine must draw the heavy load of an extra car, for there is no fresh water within that distance. And when he strikes the rapid current of the Humboldt, he has made no gain. The river is so salt and so alkaline that even marine plants cannot grow, and the river channel is like a trench with vertical walls cut through a plain destitute of every sign of life. As he follows up the stream until he reaches sweet water at last, he sees too plainly for a weary length of miles how fully it deserves the name given to it by those who formerly crossed this fearful region with teams—the "River of Death."

Along the upper Humboldt is a small amount of pasture land; there can be and is an attempt at cultivation, but it can make only a local supply, and thence onward to Salt Lake the same condition prevails.

Directly about the lake, and inclosed between the ranges of the Wahsatch Mountains, is a little good land, but its whole extent is very small, and the one thing which has forced itself on his attention by this time, and will continue to do so more and more for the next thousand miles, is that the whole country is almost absolutely *treeless*, so much so, indeed, that a single tree in Weber Cañon is one of the most conspicuous objects, bearing a sign, "The Thousand Mile Tree," as giving its distance to Omaha.

Nearly five hundred miles further he will ride before he reaches Laramie, and in that whole distance he will not have seen five hundred acres of really good land. Even the fine valley of Green River itself, charming as it is, will show him scarcely a spot to tempt a man who wishes to "make a crop." Laramie Plain, it is true, is fertile in some of its extent, and his eye will dwell on it with pleasure, but when his train has wound its way up the slope of the Black Hills, the eastern ridge of the Rocky Mountains, and from just this side of Sherman (the highest point on the road) he looks off eastward, it is like looking out to sea; the surface is apparently as level—and as bare—and the view is bounded only by the distance limiting his vision; and to the utmost stretch he sees no land which can fairly be called anything but barren. As he wheels off from the mountains and is fairly out on "the plains," the dreary barrenness begins gradually to undergo a change, but the improvement is slow. A hundred miles has helped matters somewhat; two hundred have done better, and three hundred have brought him pretty well into the range of farming land again.

This seems like a harsh account, but it only gives the impressions which repeated transits over the road have produced. Of the 1,867 miles between Omaha and San Francisco, at least 1,500 are apparently useful chiefly in that they give a firm bed on which to build the railroad, and at the same time they "hold the world together," for there must be something to preserve the continuity of the earth's surface. But they are not fitted to support a population, and they can never yield a support to the road from local productions.

Such is the line of the Central and Union Pacific. We have gone over it more in detail because it is as yet the main road of all, and we have had knowledge now for so many years of what it could do even while burdened with the heavy load of relying to such a great extent upon its extreme western limits and its eastern connections for its business. And the fact of the mighty work which it has done but forces on us a growing conviction of the grand future which is before it, even though additional and to a certain extent parallel roads may come into competition.

It is not practicable neither is it required to follow out the Southern Pacific at this moment, with the same degree of special detail; our space would not allow it. All that has been said, however, in relation to the general nature of the country traversed by the old central line, its barrenness and unfitness for human occupation, is strictly true of the southern, only that it is "more so." The terrible wastes of New Mexico and Arizona, where the only crop is cactus and rattlesnakes, and the jomadas where even these cannot flourish, are more or less known to all by published reports.

From the point where the passenger leaves the fertile lands of Southern California and strikes off eastward, there is a distance of nearly fifteen hundred miles, in which if that sort of scenery is new to him, he may be much interested because it is all strange and reminds him of what he studied in his school days about Africa and the Bedouins, but along which he will look in vain for the lands which invite settlers to come and occupy them, and which can repay occupancy with food and wealth. It is a parched land, "wherein no water is."

The fact is quite manifest that the central route and the southern route must rely for their support mainly on their "through" traffic. The possibilities of the regions which they traverse do not allow of a "way" support. They are invaluable as binding elements for the country, and as reaching regions laterally whose mineral resources can never be properly developed except in connection with their agency, but they will never be the crystallizing threads for a swarming and active population.

Now here is just where the Northern Pacific is in wide contrast with them both. It can feed itself, and, what is more to the purpose, it can feed the hungry in distant lands, as we will presently see. Whoever has lived the wonderfully fascinating life of the frontier, and has begun as the sun drew westward to watch out for a camping place at night, is well aware that he always looked for two things—grass and water—to *make a camp*. Whatever other advantages he had so much the better, but grass and water he must have at any rate. And what is true of a night's camp is equally true of the requisites for permanent habitation. No land can thrive which is not well watered, and with the water comes fertility. And in these two respects the country crossed by the Northern Pacific Railroad furnishes just what is needed to make it the abiding place of a happy and prosperous agricultural population *throughout almost its entire extent*. It is not as yet exactly a land flowing with milk and honey, but it may soon be in a certain sense, for the milk of its herds and the sugar of its sorghum crop are sure to come.

The second feature distinguishing this from the two southern lines, its predecessors, has reference to its terminal point on the Pacific waters. We will say nothing of its eastern end, for the network of communication there links all into one, so to speak, and whether you reach Lake Superior or Lake Michigan is comparatively of small import. But on the Pacific side the case is very different. For seventeen hundred miles, from Cape St. Lucas, to the straits of Fuca, there is but a single harbor which is worth being called such, the one within the Golden Gate. As a natural and inevitable result of this, San Francisco must always enjoy immense facilities for commerce. With a haven sufficient in extent for the entire trade of the world, and so completely landlocked as to be really an inland lake, and this wonderful bay opening directly out toward the money giving markets of Asia and all the Pacific, why should she not do what she has already begun so prosperously to do, grow rich from Eastern commerce.

But though Mexico, California, and Oregon have not a harbor to offer us, and scarcely even Washington itself, yet when we have come to the extreme northwest corner between Washington Territory and Vancouver's Island, there we come upon that which, if such a thing were possible, outdoes even the Bay of San Francisco. Swinging in past Cape Flattery we open a range and labyrinth of interlocking inland navigation which seems, the more you explore it, to be almost without limit, and yet to all the inhabitants of that western coast it bears the absurd name of Puget Sound, whereas that still belongs only to a small and narrow part of it away at its extreme southern end. This wonderfully, strangely magnificent sheet of water has in practical details perhaps not its equal on the face of the earth. The largest ship that ever floated can wind its way directly from the open sea for hundreds of miles through what seem like lakes, or lagoons, with water deep enough to float her up to their very banks, and yet sometimes scarcely broad enough for her to turn about in her course. Wherever she goes she finds herself shadowed by forests of evergreens fit to supply spars for a navy or lumber for all common uses, or else the level shores stretch away in the midst of fertility not easily matched.

Right in the midst of such a region as this is the objective point of the Northen Pacific Railroad. The aim was to reach the deep water of the Pacific, and it has been achieved. Tacoma lies on the very southern edge of all this range of inland navigation of which we have been speaking. There we have the western terminus, as we have the eastern at Duluth, on Lake Superior. At the wharves of Tacoma, in Commencement Bay, huge ocean steamers can receive their freight sent from New York, Boston, Philadelphia, etc., by all rail or by lake and rail, and can discharge it at Yokohama, Macao, Calcutta, or wherever it is required, and by so doing they have saved over 1,000 miles, nearer 1,500, from the distance the same freight would have traveled in reaching Asia by way of San Francisco across the Central and Union Pacific, to say nothing of the Southern.

It would seem therefore that in "through traffic" this northern route bids fair to hold its own in the way of rivalry with the older lines. It is true that the prestige of already assured success will for a long time abide with San Francisco, and give it an exceeding great advantage. It has so long been recognized as our only port on the Pacific, such a vast amount of capital has been there concentrated, and everything has so fully gravitated toward it as a center, that this hold on commercial favor will not speedily be loosened, and of course it will never be lost. Such a port as that of San Francisco cannot fail to swarm with business as long as the world stands, but after a time its monopoly of the Asiatic trade will be broken. Our merchants are quick to perceive advantages, and if a cargo of teas can reach New York even a trifle quicker by way of Tacoma than by way of San Francisco, Puget Sound will receive the fragrant freight beyond a question.

But it is not in the way of "through" business that we need to look at the Northern Pacific to perceive the reasons why we said that its completion was a matter of so much interest and so full of importance to the country. Its claims to this distinction rest on the fact that it is not a mere bond joining the eastern and western sides of the continent in one, but that the natural resources of the belt of country through which it passes are such as to invite and encourage rapid settlement of the lands not yet occupied. The great hindrance to occupation of these lands in time past has been that they were so difficult of access, and their remoteness from markets rendered any crops raised upon them valueless. This difficulty the presence of the railroad at once obviates. The surplus corn of Western Dakota or of Montana, which the farmer but a short time ago could turn to no account, unless he used it for fuel, is now worth at his nearest railroad station only a trifle less per bushel than it is in Minneapolis, Chicago, or New York.

The result of this is already manifest in a wonderful degree by the steady growth in population which has followed, and often from mere faith has preceded, the opening of each progressive section of the railroad. As fast as access to market was thus made possible, the lands were occupied and brought under cultivation, and as the accompaniment of such occupation, towns came into existence at suitable points on the roads, and every town almost without exception has grown steadily and vigorously up to this moment. They have not been mushrooms, up to-day and gone to-morrow. They have not been built and held by gamblers and the rough element of frontier life. The school house, the church, the banking house, solidly constructed of brick, the elevator for grain, the spacious warehouse, have come into existence because the men who reared them knew that the population so rapidly filling up the surrounding country comprised the best class of farmers and artisans, and constituted communities which would be a pride and an honor to any land. They had come from every region between Massachusetts Bay and Minnesota, and little foresight was needed to know that with such men came prosperity to all about them. This is what makes the hope and the glory of Dakota and the land beyond, and the making a way for such a population is what gives to the Northern Pacific Railroad its peculiar importance. In order to do this it must have "grass and water," that is, it must have fertile lands. Let us look and see.

As we strike out west from Duluth (the proper eastern terminus, the St. Paul line being one of the branches), we travel 130 miles through a timbered region. In years to come that will all doubtless be farming land, after the forests have passed away, as has been the experience in the States further east, but for the present its lumber is its wealth. Pine and hard woods thrive in perfection and will yield great results for a very long time.

Passing onward from this lumber land we strike what may fairly be called the Farmer's Home, for it is not easy to find another like it. And it is not a very small home either. Six hundred miles we roll along, and we have not come to its western border; we only find that it is not quite so broad and so wonderful as that which we had seen perhaps the day before. Within this space we have passed out of Minnesota, crossing the teeming valley of the Red River of the North and then that of the Cheyenne, have traversed the breadth of Dakota, passing the Missouri River at Bismarck, and have entered Montana, striking the Yellowstone River at Glendine. Of Dakota farming it can scarcely be necessary to speak. From the many illustrated articles in the magazines it has become widely noted, and while the "Bonanza Farmer" who sends a small army of laborers into the field and cuts his wheat by steam over square miles of surface attracts the most attention, is pictured out most beautifully, it may be very much doubted whether the true welfare of the country does not depend more closely and fully on the scores and hundreds of those hardy and intelligent men who with their own stout arms and those of their no less sturdy sons are cultivating their "quarter sections" and producing something more than corn, for they are developing bone and sinew, brain and mental as well as moral wealth for the nation.

These farms, with the business establishments which must surely come with them, are the hope of all this broad region, and it is a hope with room for almost unbounded fulfillment. The millions of people which Mr. Villard said the other day he expected to see settled along the line of this road have their basis in the productive ability of the lands on its route.

And though we have thus noted the richness of Dakota, it has been only because "out of the fullness of the heart the mouth speaketh," and it is not easy to mention the Garden of Eden in the same terms that you would apply to a cabbage patch. But in real truth the resources on either side of the road, throughout its entire length, are so great that it will take years for those who do not already know the country

to rate them at their proper value. There is an extent of at least five hundred miles after we come upon the Yellowstone where, though farming lands exist richly in the valleys and will draw a thriving population, yet the almost boundless ranges for pasture over the hills beyond will long give the character to the region, and their sheep and cattle will not only supply business for the road, but food for very distant markets.

In the heart of the Rocky Mountain section it would be naturally supposed that productive lands could not be found, and yet even here the broad valleys of the head streams of the Missouri—Jefferson's, Mattison's, and Gallatin's Forks—almost remind us of the rich farms of Dakota.

After we pass the mountains we find but the same story to tell. The country is everywhere productive in either farming products or lumber, and grows more and more so as we sweep on westward. We had run a long stretch to the northwest to get through the mountains, and then at the beautiful Lake Pend d'Oreille we turned a sharp right angle and ran about 270 miles southwest to Wallala, on the Columbia. Here we should have made another right angle and gone off northwest again to Tacoma, but this portion of the road is not yet finished, and so away we go west along that most wonderful of rivers, the Columbia, to Portland, a little over 200 miles, and then abruptly north to Tacoma, not quite 150. These two roads are both controlled by the Northern Pacific, and so we reach our terminus on Puget Sound.

We have attempted here to set forth nothing but the real advantages which give us reason to say that the completion of the Northern Pacific Railroad is an event of even greater national importance at the present moment than was that of the Central and Union in its day, though that was a totally new departure, and was truly like life from the dead. From lack of space we have necessarily touched but lightly on the features which will presently demonstrate the might of that great Northwest, but the main ones have been indicated. We have not been able even to allude to the wonders of natural scenery, but thousands upon thousands of admiring tourists will find themselves most richly repaid, year after year. The Mauvaise Terres on the Little Missouri alone are worth a voyage across the Atlantic to see, and yet they are among the minor items.

It has been supposed that the more northern line would be specially liable to obstruction from snows, and yet the practical fact is that, though difficulty will occur, it will probably be less than on the Central and Union.

## THE UNITED STATES AT THE LONDON FISHERIES EXHIBITION.

THE most effective apparatus used by the American fisherman is the purse-seine net. By it all the menhaden are captured that supply the New England manure factories with the raw material, and, as we have already said, it has practically supplanted hook and line fishing for mackerel on the American schooners. The present season, however, has not been a prosperous one for the New England seiner, and unless the fish school in great numbers than they appear to have done lately, the fishing towns of the Northeastern States will have had but a poor return for the trouble they have expended. It is, indeed, one that is subject to great fluctuations, as may be observed by consulting the chart exhibited in the United States Court, showing the amount of mackerel taken annually. In this Court is shown, says *Engineering*, a model on ½ in. scale of a mackerel purse-seine which is suspended from the roof of the building. It is extended by a large iron hoop in the position it would occupy in the water immediately after having been shot, forming a circular wall of netting, the upper edge being supported by the corks and the lower edge sunk by the weights. A model, on the same scale, of a mackerel schooner fully rigged and with all sail set is hung beside it. Fig. 1 shows the net in this position; it must be understood, however, that the boat shown is not to scale, as the net is frequently 200 fathoms long.

The details of the purse-seine vary according to the purpose for which it is required, and as the ideas of the fishermen may alter. For many years this net was used principally, if not solely, for taking menhaden. The early menhaden seines were 200 yards in length, having a 2½ in. mesh stretched measure, there being 350 meshes in the bunt of the seine. Of late years there has been a considerable increase in the size of the net, which is now made 185 fathoms long, and about 8½ fathoms deep, the weight being about 700 lb.

For mackerel fishing two sizes of seines are employed, the larger of which will sometimes measure even 225 fathoms in length and be 25 fathoms deep when shot. It is deeper in the center of the bunt than at the extreme wings, one of which will be 10 fathoms deep, and the other end 15 fathoms. These are probably maximum dimensions. There is, however, no arbitrary rule as to the dimensions of the net at the ends, some fishermen preferring them very shallow, so that they may be as shallow as one and seven fathoms respectively; others maintain that the fish have less chance of escaping if the ends be deep. The deeper end is called the dorey end, and the shallower the boat end. The net is made of three kinds of twine, the strength of which is proportioned to the strain that will be put upon it. The bailing piece, which is a section of the net occupying about ten to twelve fathoms in length and depth at the center, is made of the stoutest twine.

Beneath this and extending to the bottom of the net is a section knit of twine a size smaller. There is also a band of large twine fifteen meshes deep extending along the cork line of the seine on either side of the bailing piece to the extremity of each wing. The remainder of the net is made of smaller twine. On the cork line are two or three sizes of corks, the largest being placed over the bailing piece, the smallest generally at the ends of the wings. The center cork is larger than the others, and is usually painted or covered with canvas in order that it may be easy to find the center of the net, either by night or day. A buoy is attached to the end of the cork line at the corner of the wing which is first thrown out when the seine is set. The net is hung to lines which are called the hanging lines.

The lead line is placed as in an ordinary seine, and is weighted with sinkers which are attached at intervals varying from a few inches to several feet. The pursing rings are attached to the foot of the net by means of bridles in the manner shown in the illustrations. When working in strong tides, in order to bring the ends of the net together a weight is used, as shown in Fig. 3. In the present day it is customary to use two weights in place of one, these weights being allowed to slide down when the net is shot and before the pursing commences. The pursing line is rove through the rings and usually has a brass swivel exactly in the center, which prevents the line from kinking. The middle ring is often made from different metal to the others in order that the center of the net may be easily found.

The following dimensions of an average-sized deep-water mackerel purse-seine have been supplied by Captain George Merchant, Junior, of Gloucester, Massachusetts: Total length of seine when hung, 208 fathoms; depth, 1000 meshes, or about 21 fathoms; size of mesh in all its parts, 2 in.; length of bailing piece or bunt, 500 meshes; size of twine, 12-9; depth of bailing piece, 500 meshes; length of sides, each 300 meshes, size of twine 20-9; depth of sides, 500 meshes; length of "under," 1100 meshes; size of twine, 20-9; depth of "under," 500 meshes. The central section, composed of the bailing piece, sides, and under, is called the bunt, though the bunt proper constitutes only a small portion of it. The wings and arms extend on each side of

THE SPENCER F. BAIRD, MACKEREL SCHOONER.

the central part, and sometimes are of considerable difference in length, as many of the seiners prefer to have the bunt of their seines a little to one side of the middle of the net.

For instance, one wing and arm might be 125 yards each in the web, while, the second wing and arm would be 150 yards each in the web, the whole being 1000 meshes deep. The wings would be made of twine 16-6 hawser laid, with the exception of the border, about 15 meshes deep, which would be of stronger material, while the arms would be 20-6 twine hawser laid, again excepting the border, which might be a trifle stouter. For hangings, six-thread Manila right and left rope is used. In the Boston factories nine-thread Manila is used for bridle rope, or loops as they are commonly called. These loops, to which the purse-rings are attached at the bottom of the seine, are formed by one part of the hanging rope, and made three fathoms long, the spaces between them being the same distance; thus it will be seen that the purse-rings are spaced about six fathoms. Left-laid rope is used for loops and right for sinkers. The loops are formed by separating the ropes at the bridle hitches, one ring being attached to each loop. The net is sufficiently corked, and from 65 lb. to 75 lb. of lead sinkers, say from 2½ oz. to 4 oz. each, are placed along the bottom.

None of these are put in the bunt, but are scattered along the foot of the wings and arms, being nearest together close to the ends of the net. The rings used are made of galvanized 1 in. iron and weigh 2½ lb. each,* and with the sinkers they make up about 160 lb weight attached to the bottom of the seine. For the pursing rope, 1¼ in. hemp line is used, it is generally about 25 fathoms longer than the net. Any difference in depth of the several sections of net may be accounted for by the taking up in the process of hanging, the webbing being of the same depth throughout.

It is now necessary to give some particulars of the boats from which this net is shot. Captain George Merchant is said to have been the first to adopt a sharp-sterned boat for purse-seining in the year 1856, previously to which time square-sterned clinker-built boats were used. Messrs. Higgins and Gifford, of Gloucester, Massachusetts, are in the present day the chief builders of these vessels. A beautiful model of a seine boat made by this firm is shown in the Exhibition, and has excited the admiration of more than one expert from the head-quarters of our own seine fishery. According to Mr. Gifford, the leading qualifications required in a seine boat are:

1. That it should tow well; consequently it is made sharp forward. A whale-boat, which is somewhat similar in general appearance, should, on the other hand, be finer aft, so that she may be backed easily after the whale has been struck. —2. It should row well, and this quality is obtained by the sharp bow; the whale-boat should also row well, but in this case it has been found desirable partly to sacrifice speed to the additional safety attained by having the stern sharper than the bow.—3. It should be stiff or steady in the water, since the operation of shooting the seine necessitates much moving about in the boat. The seine boat of the present day is a modification of the old-fashioned whale-boat combining the qualities mentioned above. The average length of such a boat is about 34 ft., its width 7 ft. 5 in., its depth amidships 33 in. At the stern is a platform 6 in. to 8 in. below the gunwale, measuring about 4 ft. fore and aft, on which the steersman stands. Another platform extends the whole length of the boat's bottom, from the after part of which the seine is set.

In the bow is a third platform on which the man stands who hauls the cork line. There are four thwarts or seats, a large space being left clear behind the middle of the boat for the storage of the seines. Upon the starboard side of the boat near the middle is placed an upright iron support about 18 in. in height, to which are attached two iron snatch-blocks; through these are rove the purse-rope. Upon the opposite side of the boat, generally near the bow and stern, are fixed in the gunwale two staples to which are attached other snatch-blocks used to secure additional purchase upon the purse-ropes. A wooden pump is provided for discharging the large quantity of water brought on board when hauling the seine. The boats are carvel built, and are steered by an oar. In the present day two seine boats of different sizes are often attached to a schooner. These are taken on deck while making a passage, but when on the fishing ground, they are towed or moored astern. They have canvas covers, and will ride out heavy gales with safety made fast to the schooner's stern.

In the United States Fish Commission report on the mackerel fishery, from which we are quoting largely, it is stated that Messrs. Higgins and Gifford are the principal, if not the only, constructors of these boats. The prices charged for them may be of interest to the English fisherman.

*Seine Boats, including Pump, Iron Breast Hook, outside Tow Iron, and Iron Stem Cap.*

| | Dols. |
|---|---|
| Smooth bottom battened seam, 31 ft. .... | 186.00 |
| " " 36 ft.*.... | 225.00 |
| Galvanized rowlocks with brass sockets, per set of eight..... | 6.50 |
| Pursing gear..... | 8.50 |
| Patent steering rowlock with socket..... | 1.25 |
| Pursing blocks, per pair..... | 6.00 |
| Towing iron and pin..... | 2.00 |

A purse-seine net complete, about 200 fathoms long, and 21 fathoms deep, would cost from 850 dols. to 1000 dols.

The dorey is a flat-bottomed craft was high, flaring sides; it measures about 15 ft. on the bottom. There are models and full-sized specimens to be seen in the Exhibition. They are, to those unaccustomed to such craft, most unprepossessing looking boats, but have valuable qualities for fishing purposes, and play a most important part in the New England fisheries, either on the ocean banks or off shore. There are two doreys attached to each schooner when engaged on a seining voyage. The schooners themselves, which form the base from which the mackerel seining operations are carried on, are probably the most beautiful fishing craft in the world.

Our illustration of the Spencer F. Baird, taken from a model in the Exhibition, will serve to show the way in which

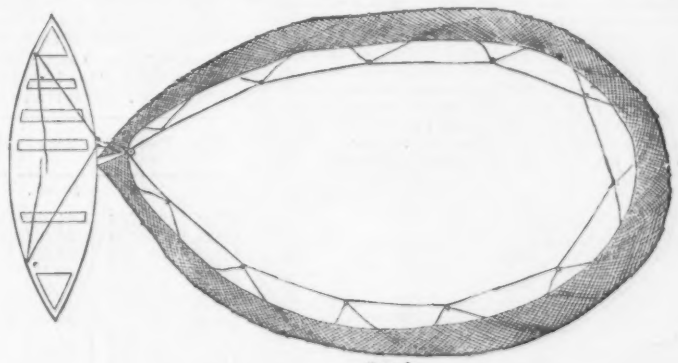


FIG. 1.

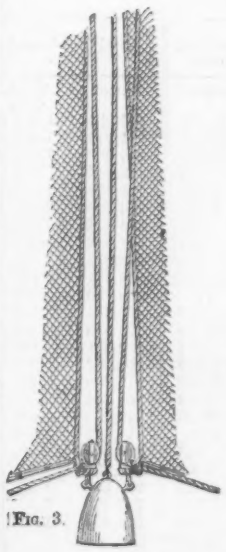


FIG. 3.

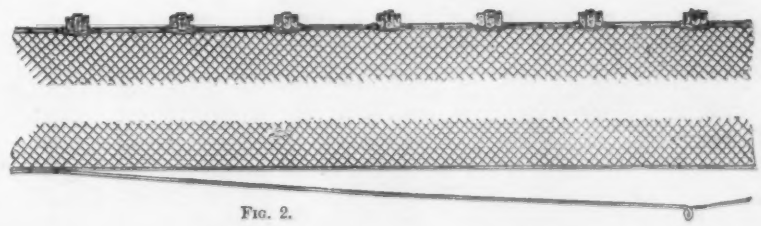


FIG. 2.

the vessels are rigged, excepting that in our illustration there is no foretop-mast and outer jib. We intend giving at a future time the lines of an American schooner, and on that occasion shall refer more fully to the details of construction and rig. When a vessel is on the fishing grounds a man is stationed at the masthead on the lookout, and if signs of fish be observed, either by sea-birds gathering or whales and porpoises showing frequently, the schooner will be headed for that part. When the vessel has been brought sufficiently near to the school, the seine boat and dorey are promptly manned. The skipper takes the steering oar in the seine boat. Two men sit on the forward part of the bunt, and one is placed at the cork line, ready to shoot the net, the remaining men, seven in number, manning the oars.

Considerable skill is required in order to shoot the seine

* Captain Merchant has invented an iron block which is said to be a great improvement on the rings.

* Intermediate sizes are made.

properly, as it is highly desirable to make the net surround the school. If the fish are "cartwheeling" or circling round in the act of feeding, the operation is comparatively easy, but when they are swimming straight ahead considerable skill and a good crew are required in order to make the wings of the net meet around the school.

As soon as the first end of the seine has been thrown overboard from the boat, the two men in the dorey row up to and seize the buoy at the end of the cork line, which they hold until the seine boat has made the circle, merely rowing hard enough to keep the end of the seine from sagging. When the two boats meet, the men in the dorey get into the seine boat and assist in the work of pursing up, which is now performed with all possible speed. The seine at this period forms a circular wall of netting in the water, and the fish are at liberty to escape by sinking to the bottom, or diving below the lead line, and it is by pursing that the

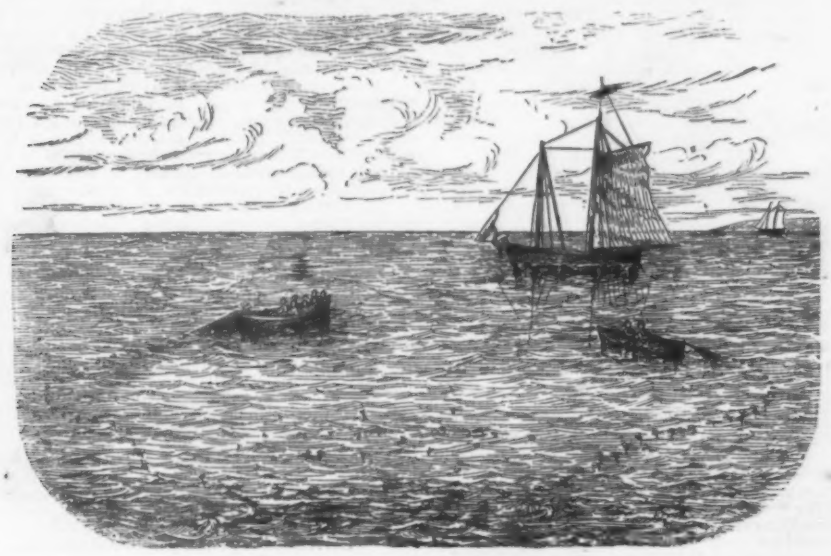


FIG. 4.—SHOOTING THE SEINE.

bottom of the net is inclosed. The men stand, six in one end of the seine boat, and seven in the other, holding between them the two ends of the purse line, the latter, as already explained, being passed through the rings attached to the foot of the seine by the bridles. The purse line is rove through snatch-blocks hung on the davit before referred to.* Until a strain is put on the pursing rope, the bridles at the foot of the net will hang downward, being kept in a vertical direction by the weight of the iron rings, but as soon as the men begin to haul, the bridles will be drawn inward in a horizontal direction. As the pursing up continues, the rings will be drawn closer and closer together, the net being puckered in at the bottom, until at last it will practically form a close-bottomed purse or bag; the bottom, however, does not hang freely, it being drawn to the boat during the pursing.

The operation of "drying up" now begins, and is carried on by the net being hauled into the boat in order to bring the fish into small compass. The reason of the extra strength of twine in the bailing piece is now apparent, as it is in this part that the school is last inclosed, and this having been accomplished, it now only remains to transfer the fish from the net to the dorey, and the whole operation is complete. Sometimes, however, the school will be too large for the two boats to manage alone, in which case the dorey is rowed to the schooner, and the second dorey will be taken to the net for the purpose of holding up the bunt, since a large school of 500 barrels may sink both seine and seine boat if the latter be left without assistance. While

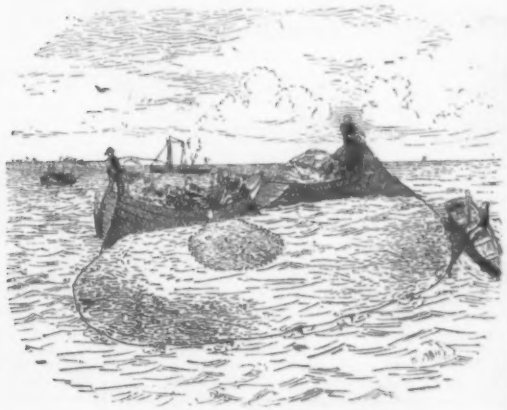


FIG. 5.—PURSING THE SEINE.

the seine is being shot, one hand, generally the cook, is left in charge of the vessel, and should there be such a quantity of fish inclosed in the net that the boats cannot handle them, the cook and the dorey men at once endeavor to bring the schooner to the net. The evolution of shooting alongside a seine boat necessitates considerable skill in maneuvering the vessel and an intimate knowledge of her way of steering. The schooner must approach so near that a rope may be thrown to the men in the seine boat, and this having been bent to the net, the vessel must move slowly enough not to tear the seine before her way can be stopped by being brought head to wind.

The cork line is then taken over the side of the vessel and made fast by stoppers along the rail. This having been done, the fish are got directly on to the schooner by means of a large dip net attached to the main and fore staysail halyards. The operation of setting a seine and pursing it will in ordinary cases occupy ten or twelve minutes, although an hour or more will sometimes be required to finish the work. The catch may vary between one barrel to five or even six hundred, and at times the whole school may escape by diving below the lead line. Occasionally, too, the net will be broken by the rushes of the large quantity of fish inclosed.

Almost incredible quantities of fish can be taken by purse-seining in a short space of time. Vessels have been known to leave New York on one day and return the next with 200 to 300 barrels of fresh mackerel, while some Gloucester schooners in the course of a week have caught and salted 500 to 600 barrels, landing two or three cargoes during that time. During the summer and autumn of 1881 the schooner Edward E. Webster stocked 24,146 dols. In the season of 1880, the schooner Alice took 3,700 barrels, of which 900 barrels were disposed of fresh, stocking 19,584.76 dols. The schooner Lizzie D. Saunders stocked 1,700 dols. in two weeks, the crew sharing 75 dols. The schooner Wildfire packed 1,300 barrels in six weeks. Other vessels took respectively 400 barrels in four days, 205 barrels in 21 hours, 210 barrels in one haul, and 225 barrels in one day.

When a crew have taken more fish than they can handle, they will signal to any other vessel that may be in the vicinity to help them with the take, and it is not a very uncommon occurrence to see the schooners come into port completely laden, and with both doreys in tow also full of fish. Of late years the practice of seining by moonlight has been introduced, the schools being readily perceived by the phosphorescent wake they leave in passing through the water. English drift-net fishers dread this phosphorescence more than anything else, as it enables the fish to see the nets; American fisherman, on the other hand, find the phenomenon contribute in no small degree to their success.

The following table shows the number of barrels and value of pickled mackerel produced by the fisheries of the United States for the years mentioned:

*Number of Barrels and Value of Pickled Mackerel produced by Fisheries of the United States for the Years* 1831, 1834 *to* 1838, 1851, 1864 *to* 1881.

| Years. | Massachusetts. | Maine. | New Hampshire. | Total Quantity and Value. | |
|---|---|---|---|---|---|
| | Barrels. | Barrels. | Barrels. | Barrels. | Value, dolls. |
| 1831 | 283,548 | 44,951 | 21,450 | 449,950 | 1,862,793 |
| 1834 | 252,879 | 40,661 | 18,200 | 311,740 | 1,437,123 |
| 1836 | 174,410 | 25,228 | 9,450 | 209,088 | 1,520,069 |
| 1837 | 138,157 | 22,462 | 5 225 | 165,844 | 965,214 |
| 1838 | 110,740 | 24,312 | 3,420 | 138,472 | 1,156,243 |
| 1851 | 329,244 | 31,472 | 3,073 | 363,789 | 2,484,679 |
| 1864 | 274,357 | 49,797 | 300 | 324,454 | 7,001,098 |
| 1865 | 256,796 | 54,215 | 45 | 311,056 | 5,729,851 |
| 1866 | 231,696 | 44,627 | 200 | 276,523 | 5,161,261 |
| 1867 | 210,314 | 33 675 | 572 | 244,561 | 3,174,190 |
| 1868 | 180,056 | 28,774 | .... | 208,830 | 2,924,987 |
| 1869 | 234,210 | 37,166 | 157 | 271,534 | 3,762,985 |
| 1870 | 318,521 | 52,304 | 3,700 | 374,525 | 4,400,563 |
| 1871 | 259,416 | 48,603 | 2,071 | 310,091 | 2,668,851 |
| 1872 | 181,956 | 22,173 | 1,878 | 206,007 | 2,205,761 |
| 1873 | 185,748 | 22,193 | 2,398 | 210,350 | 3,167,948 |
| 1874 | 358,379 | 43,741 | 5,519 | 307,640 | 3,163,701 |
| 1875 | 130,062 | 9,502 | 3,415 | 142,980 | 1,439,315 |
| 1876 | 225,942 | 22,429 | 5,351 | 253,722 | 1,853,103 |
| 1877 | 105,097 | 22,157 | 643 | 127,898 | 1,384,223 |
| 1878 | 144,205 | 48,263 | 4,000 | 196,468 | 1,408,675 |
| 1879 | 156,125 | 58,249 | 6,225 | 220 599 | 1,268,444 |
| 1880 | 255,986 | 86,338 | 7,350 | 349,674 | 2,398,004 |
| 1881 | 269,495 | 116,762 | 5 400 | 391,657 | 2,447,556 |

* The figures for the years 1834 to 1838 and 1851 are from Sabine's Report on the American Fisheries; for the years 1864 to 1877 from the State inspection returns; for the years 1878 to 1881 from the annual reports of the Boston Fish Bureau.

For the greater part of the data used in compiling this account of the United States mackerel fishery we are indebted to the valuable report issued by the United States Fish Commission.

PHOSPHORIC acid from bone-black superphosphate was found to increase the yield of wheat more than any other plant food. The addition of potassa, and especially of potassa and nitrogen, to the phosphoric acid gave an increased return of grain, and still more of straw. An increase of the nitrogen did not effect any proportionate increase of the harvest. The increase of the crop by the application of farm-yard manure was less decided than a complete dressing with artificial manures. Lime, ground limestone, and gypsum produced no effect worth mention.—*Prof. W. H. Jordan.*

* Our cuts are taken from a U. S. Fish Commission illustration of purse-seining for menhaden; and although the details differ somewhat from those of mackerel fishing, the general principal is the same in both fisheries.

## ASSAY OF LINSEED OIL.

IN a small flask there are mixed equal measures of the oil boiled or raw, and of nitric acid of sp. gr. 1·40. The mixture is shaken briskly for half a minute, and let stand for some time. When the separation of the oil and the acid is complete, the color of the two strata is examined. If the upper layer is of a light cinnamon and the lower colorless, the sample is pure. If the upper stratum is either as above, of a deep olive or a black, while the lower is straw-color or orange, resin is present in quantities from 5 to 50 per cent. according to the intensity of the color. If the upper layer is cinnamon-brown while the lower is colorless, the sample is genuine boiled oil. If the upper stratum is olive or black, and the lower of a pale or darker straw up to an orange, resin oil is present from 5 to 50 per cent.

## PURIFICATION OF POLLUTED WATERS.

By PROF. J. KÖNIG.

THE author proposes to purify town sewage and the waste waters of slaughter houses, dye works, breweries, etc., by allowing them to trickle over a net work of wire, thus exposing a large surface to the oxidizing action of the atmosphere. He recommends that the coarser impurities should first be got rid of by means of settling tanks, and he mentions that the same result has been aimed at by allowing the water to flow over "graduation works," i. e., thorns or bushes piled up in the shape of a high thin wall.

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